FINAL

SANTA CLARA VALLEY RUNOFF POLLUTION PREVENTION PROGRAM

METALS CONTROL MEASURES PLAN (VOLUME I) AND EVALUATION OF NINE METALS OF CONCERN (VOLUME II)

February 12, 1997

Participating Agencies
Campbell, Cupertino, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara County, Saratoga, Sunnyvale, and the Santa Clara Valley Water District

Volume I

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EXECUTIVE SUMMARY

In August 1995, the San Francisco Bay Regional Water Quality Control Board (RWQCB) reissued the second 5-year NPDES permit to the Santa Clara Valley Urban Runoff Pollution Prevention Program (Program) that includes 13 cities, and portions of the Santa Clara Valley Water District and Santa Clara County that drain to the South San Francisco Bay. One of the permit provisions required the Program to develop a Revised Metals Control Measures Plan to reduce copper and other metals in storm water. The permit provision required that this plan address controls for nine metals (identified in the Program's previous permit as 304(l) metals). However, a metal that has no controllable sources associated with storm water discharges or does not result in adverse impacts to the beneficial uses may be removed from the Metals Control Measures Plan.

In compliance with the Permit Provision C.6, the Program has conducted a three part study that comprises:

- Evaluation of the environmental significance of nine metals (i.e., likelihood that metals would have adverse effects on beneficial uses if discharged to surface waters). This evaluation is summarized in Section 3.0 of Volume I and presented in detail in Volume II.
- Identification of sources of *metals of concern* within the Santa Clara Valley watershed, and estimation of relative contributions to the South Bay from these sources. This is presented in Section 5.0 of Volume I.
- Identification and evaluation of existing and new control measures for their ability to control the larger urban sources of *metals of concern*. This is presented in Section 6.0 of Volume I.

Results of this three part study are summarized in this report. The Metals Control Measures Plan is presented in Section 6.0.

Environmental Significance Evaluation. The evaluation of the environmental significance of the nine metals was performed in two steps. As a first step, the nine metals were ranked in terms of their relative environmental significance i.e., their potential to adversely affect the beneficial uses of the receiving waters. Water quality data were compared to available EPA and RWQCB regulatory criteria. Sediment and tissue data were compared to criteria suggested in the literature. Exceedances of the criteria were used to determine the relative rank or significance of each metal. As a second step, this ranking was presented to a Scientific Peer Review Panel for review and comment. This panel consisted of professors from the University of California and other experts from the USGS, Applied Marine Science Inc., and the San Francisco Estuary Institute. Based on ranking and panel recommendations, the nine metals were divided into three classes: *Pollutants (metals) of concern* (copper, nickel, mercury, silver, and selenium); *Pollutants requiring additional investigation* (cadmium, lead, and zinc); and *Pollutants Not of Concern* (chromium). Based on this analysis, it was decided that *pollutants of concern* would be the focus of source identification and control development. For *pollutants requiring additional investigation*, this report recommends research needs to clarify the significance of these metals

(so that they can be assigned to either the *Pollutant of Concern* category or to the *Pollutants Not of Concern* category).

<u>**Source Identification and Estimation of Loads**</u>. Potential sources of the five *pollutants of concern* were identified and examined for their contribution to metal loads in the Bay. These included point sources (POTWs), urban nonpoint sources (including industrial/commercial; fertilizer and pesticide applications; construction erosion; industrial stack and tailpipe emissions; automotive sources; and water supply) and other non-urban nonpoint sources (including mining, reservoir releases, and natural/open space erosion). Limitations of data and methodological analysis resulted in uncertainty with respect to several of the load estimates that were prepared for these sources. However, the estimates did provide some understanding of the relative significance of each source and the types of metals associated with each source, as well as revealed areas where further studies are necessary. The main findings of the loads estimate are:

- Urban nonpoint sources contribute more than half the copper (53 percent) discharged to the South Bay, therefore, this *pollutant of concern* and its sources should be the main focus of the Control Measures Plan.
- Of the copper load contributed by urban nonpoint sources, more than 80 percent is attributable to automobiles (brake pads primarily).
- Urban nonpoint sources contribute 39 percent of mercury to the South Bay, and therefore, this *pollutant of concern* and its primary urban nonpoint source (tailpipe emissions) are of importance.
- Urban nonpoint sources contribute 13 percent of the nickel loads to the South Bay, and therefore this *pollutant of concern* and its primary urban nonpoint sources (tailpipe emissions, construction sites, and industrial facilities) are of importance.
- Point sources contribute 78 percent of the selenium load and 86 percent of the silver load to the South Bay. However, nonpoint sources are most likely significant and urban and non-urban sources appear to contribute comparable portions to the total nonpoint load.
- Of the urban nonpoint sources, the automobile emerges as the single most significant source of *metals of concern*. Industrial facilities, water supply, and construction site erosion contribute less significant proportions of total metals loading.

<u>**Metals Control Measures Plan**</u>. The third phase of this study focusses on new and existing control measures to address urban sources of *pollutants of concern*.

The Program currently pursues a comprehensive set of activities that are intended to reduce the quantity of pollutants including metals entering storm drains. Ongoing efforts include street sweeping, storm drain cleaning, maintenance of corporation yards and other municipal facilities, enforcement of erosion control measures at construction sites, regulation of post-development

runoff water quality, prevention of illicit discharges, inspection of industrial and commercial facilities, and monitoring of the drainage system. In addition, the Program continues to educate the public about the importance of, and techniques for preventing, urban runoff pollution.

The Plan emphasizes control of copper, because, unlike nickel, mercury, silver and selenium loads, the copper load is predominantly urban, and the urban portion of the watershed is considered the jurisdiction of the Program. The Program will work with the Santa Clara Basin Watershed Management Initiative (WMI) and other agencies to investigate effects of, and controls for, nonurban metals sources. The Plan emphasizes source controls, as opposed to treatment controls that attempt to remove copper after it has been dispersed onto streets and into the storm drainage system.

Industrial and construction site sources are considered within the jurisdiction of the Program and the following additional metals control measures will be implemented to address these sources.

INDUSTRIAL-1	Assist industry, on a pilot program basis, to develop storm water sampling and analysis protocols and conduct independent spot-checking to verify SWRCB industrial data.
INDUSTRIAL-2	If relatively high concentrations of metals in runoff from targeted industrial categories are confirmed, collaborate with industry to investigate potential pathways and develop appropriate BMPs.
EROSION-1	Implement Performance Standards for Construction Inspection.
EROSION-2	Participate in development of a region-wide training and certification program for construction site inspectors.

The Program will incorporate these control measures into its forthcoming Urban Runoff Management Plan (URMP) scheduled for completion in September 1997. Implementation details regarding tasks to be completed, schedule, and responsibilities for implementation will be provided in the URMP.

The sources associated with vehicle brake pad wear and emissions from vehicles and industries are not under the jurisdiction of the Program. However, given the apparent importance of these sources, the Program will work with other agencies to help control these sources.

AUTO-1	Support Brake Pad Partnership efforts to promote reformulation of friction materials in brake pads.
AUTO-2	Participate in educating the storm water community (agency staff, regulatory staff, elected officials, consultants) about the significance of metals loading from brake pads.
AUTO-3	Participate in educating the public about the significance of metals loading from brake pads.
AUTO-4	Monitor, and respond to research reports that could lead to an effective methodology for prioritizing cleaning of "hot spot" catch basins.
AIR-1	Support BAAQMD to reduce metals emissions from diesel-powered vehicles, and with the CMA to reduce, through congestion management, metals emissions from all vehicles.
AIR-2	Support BAAQMD implementation of Toxic Air Contaminant Reduction Plan

In addition to measures identified, the Program continues to seek opportunities to control pollutants from urban sources that enter storm water runoff.

In August, 1995, the San Francisco Bay Regional Water Quality Control Board (RWQCB) re-issued the second 5-year storm water NPDES Permit to the 15 agencies who are co-permittees in the Santa Clara Valley Urban Runoff Pollution Prevention Program (Program). Provision 6 of the Permit required the Program to develop a Metals Control Measures Plan that "assigns responsibilities and establishes timelines to define and implement short term and long term copper reduction measures and control measures for other metals of concern." The provision provided the Program with the opportunity to determine what metals should be considered in the plan based on a controllability criterion and an environmental criterion, namely that the "metal has no controllable sources associated with storm water discharges or does not result in adverse impacts to beneficial uses." The date for submittal of the Plan to the RWQCB was September 1, 1996 and, after approval of the RWQCB's Executive Officer, the plan was intended to be incorporated into the Program's Storm water Management Plan.

In response to the Permit Provision, the Program conducted a three part study that consisted of:

- environmental significance evaluation,
- source identification and estimation of loads, and
- control evaluation and development of a new Metals Control Measures Plan.

The environmental significance evaluation is included as Volume I of this report. The metals source identification and corresponding load estimates, and control measures plan are included as Volume II.

The environmental significance evaluation was conducted for nine metals: cadmium, chromium, copper, lead, nickel, mercury, selenium, silver, and zinc. The objective of this evaluation was to determine which of the nine metals were of significant environmental concern so that a metals control plan could be developed that focused on the *metals of concern*. The evaluation consisted of a two step process: comparison of water, sediment, and tissue data from the South Bay and tributary streams with regulatory criteria established by the EPA and RWQCB, and a best professional judgment determination of a Scientific Peer Review Panel. Copper, nickel, mercury, silver, and selenium were identified as *pollutants (metals) of concern*; cadmium, lead, and zinc were identified as pollutants requiring additional investigation; chromium was classified as a pollutant not of concern. The results of this evaluation were provided to the RWQCB on June 3, 1996.

Based on the results of the environmental significance evaluation, sources of environmentally significant metals (*pollutants of concern*) were identified and estimates of the contribution of these sources to the South Bay were prepared. Such sources were divided into three categories, point sources, nonpoint sources associated with urban activities, and other nonpoint sources. This division was found to be convenient in that it helped to address the controllability criteria discussed in the Permit.

A control measures plan was then developed that evaluated current control measures that address the nonpoint urban sources, recommended enhancements to these ongoing activities, and recommended possible additional control activities. The control evaluation emphasized source control measures as these are considered the best long-term solution to the metals problem in the South Bay.

The Project also included a stakeholder involvement process by which a number of stakeholders representing environmental, business, and other groups participated in identifying issues of concern and reviewing and commenting on draft reports.

The Project was conducted by a consultant team consisting of Woodward-Clyde Consultants, Eisenberg, Olivieri, and Associates (EOA), and Michael Drennan Associates. The Senior Peer Review Panel consisted of Dr. Sam Luoma of the United States Geological Survey, Professor Russ Flegal of the University of California at Santa Cruz, Dr. Robert Spies of Applied Marine Sciences, Inc., Dr. Angus McGrath at University of California at Berkeley Lawrence Berkeley Laboratory, and Dr. Rainer Hoenicke of the San Francisco Estuary Institute. Project oversight was provided by Program Staff and the Program's NPDES Permit Committee.

This project builds on the results of previous related efforts conducted by the Program. In 1991, the Program completed 2 years of dry weather and storm water monitoring that culminated in an estimate of the mean annual loads of metals from Santa Clara Valley to the Lower South Bay (Woodward-Clyde 1991). In an effort to identify the source of these loads, the Program then conducted a source identification study that looked at a variety of sources including automotive, atmospheric, and residential sources and controls (Woodward-Clyde 1992). As a follow-up to this study, a focused study on brake pads as a source of copper was conducted (Woodward-Clyde 1994) and this work continues through the efforts of the Brake Pad Partnership, a cooperative venture led by Common Ground for the Environment at Stanford University. In 1994, in response to a copper waste load allocation developed by the RWQCB, the Program participated in a Copper Reduction Dialogue amongst point and nonpoint source dischargers and other stakeholders which identified copper sources and controls and developed a memorandum of understanding between the dischargers regarding implementation (SCVNPSPCP 1994). Many of these controls were then incorporated into the metals control element of the Program's second SWMP. As part of the re-issued permit, the Program was also required to submit an interim metals control plan for FY 1996-97.

Volume I of this report is organized as follows. Section 2 summarizes the stakeholder involvement process. Section 3 summarizes the findings of the metals environmental significance evaluation that was completed as a stand alone report and is presented as Volume 2 of the current report. Section 4 addresses some refinements to the 1991 estimates of nonpoint source loading to the South Bay based on more recent data. Section 5 identifies and estimates the contribution of various point and nonpoint sources; and Section 6 describes the control options, and a draft implementation plan for the Program.

The Program's main goal of the Metals Control Measures Plan is not merely to satisfy the requirements of the NPDES permit; it is also to find out what the real environmental problems are with metals in the South Bay and determine the most cost-effective way to address them. To reach this goal, the Program recognized early on it is very important to understand the stakeholders' concerns up front and involve them in reviews throughout the project. The Program also developed a Scientific Peer Review Panel to provide technical review and add credibility to the process.

The following steps were used to obtain input from the stakeholder community. A description of each of the steps is included below.

- Develop a list of stakeholders
- Conduct formal interviews with each stakeholder to identify issues
- Document the interviews
- Provide opportunity for each stakeholder to review the text of the interview document to assure accuracy
- Summarize and distribute the key issues raised in the interviews
- Incorporate stakeholders' concerns into the project
- Provide formal opportunities for stakeholders to review draft reports

2.1 DEVELOP A LIST OF STAKEHOLDERS

A list of stakeholders (including all co-permittees) was initially developed based on an understanding of the interests in the community. That list was subsequently expanded by asking each of the original stakeholders to provide input on the completeness of the list. Many additional stakeholders were placed on the final stakeholder list as a result of this exercise.

An initial letter dated February 27, 1996 was mailed at the very beginning of the project to each stakeholder informing them about the proposed stakeholder coordination process as well as the proposed approach for developing the report and its conclusions. Stakeholders were requested to respond to the letter if they were interested in participating in the stakeholder process or had any additional information or comments about the project and the proposed approach.

Several responses were received from stakeholders regarding:

a) their interest in participating in the process,

b) the proposed approach

c) additional information sources to support the metals evaluation.

These comments were incorporated into the initial phase of the project.

2.2 CONDUCT FORMAL INTERVIEWS WITH STAKEHOLDERS TO IDENTIFY ISSUES

Each stakeholder was subsequently contacted by phone to determine if they were interested in participating in the stakeholder process regardless of whether or not they had responded in writing to the original letter. Contact by phone was determined by the Program to be a necessary step in their outreach process to assure that all parties had been provided ample opportunity to review and comment on the February letter.

As a result of the phone contact, a significantly larger portion of the identified stakeholders expressed an interest in participating in the process. In addition to the 15 co-permittees, approximately 50 stakeholders expressed interest in participating in the process. About half of them were interested in actively participating in the interview process, while the other half expressed interest in being kept informed about the progress of the project.

Once a stakeholder expressed interest, an overview of the project approach was presented during the months of March and April in person or by phone by the project consulting team. The description of the approach included the following script:

> *"The first step in this project is to revisit the regulatory metals list and all of the data available to date on the impacts of these metals on the Bay. We want to evaluate which of these metals are still considered to be a problem and which ones we are uncertain about. We will look at a variety of indicators for each metal and use a "weight-of-evidence" approach to decide whether a metal is not a problem, possibly a problem, or definitely a problem. This will help us decide where to focus our attention in developing control measures. We will use input from the stakeholder and the peer review panel to help us do the evaluation.*
>
> *The second step will be to take the metals of concern and look at: what are the sources in the watershed as a whole and what portion of the problem is under the control of the Nonpoint Source Program? Our goal in this step is to develop pie charts for each metal showing the relative contributions of each major source. We will also look at the relative effectiveness of control measures so that all parties and environmental decision-makers will be able to make more informed decisions about the most cost-effective solutions to implement in the watershed.*
>
> *Finally, we will prepare a Metals Control Measures Plan which describes recommended measures to address sources of important metals that are controllable by the Program."*

In addition, the following concepts and issues were presented to each of the stakeholders:

- Early stakeholder interviews to solicit input prior to any written documents
- Scientific peer review panel
- Sources of data to be utilized in the process of determining existing environmental conditions.
- Draft technical memos as described in the scope of work
- Evaluation criteria
- Weight-of-evidence approach to determining environmental significance of metals
- Categorization of metals of concern into three groups: significant, not significant, and insufficient data
- Identification of sources of significant metals
- Identification of sources controllable by the Program
- Development of the Metals Control Measures Plan
- Formal stakeholder input on each draft technical memo and the draft Plan

The process of conducting the interviews was designed to solicit input on all of the issues described above. A formal interview questionnaire was developed and utilized in each interview.

2.3 DOCUMENT THE INTERVIEWS

Responses were recorded on the questionnaire by the project team members. To assure accuracy the draft versions of each completed questionnaire were distributed to the person interviewed. Revisions were received on each documented interview and incorporated into final versions of the completed questionnaires.

2.4 SUMMARIZE AND DISTRIBUTE THE KEY ISSUES RAISED IN THE INTERVIEWS

A memorandum dated May 5, 1996 summarizing the key issues raised by stakeholders was prepared for review by the Program staff, project team and the stakeholders. Stakeholders expressed general agreement on the need for the Metals Control Measures Plan to serve as a tool for decision-makers to effectively allocate limited resources on controlling the most significant sources of the metals of most environmental significance. The memorandum is attached to this report as Appendix A.

Additionally, copies of the interview documents with each stakeholder were made available for review to all stakeholders.

2.5 INCORPORATE STAKEHOLDERS' CONCERNS INTO THE PROJECT

The questionnaire was prepared in such a way as to follow the phases of the project. The Program staff and project team were advised about all comments received from the stakeholders on each project phase. Comments and concerns were incorporated into each project phase.

2.6 PROVIDE FORMAL OPPORTUNITIES FOR STAKEHOLDERS TO REVIEW DRAFT REPORTS

Each project phase includes a draft technical memorandum or draft report as a work product which described the approach of the project phase, the work performed, the preliminary conclusions developed, and the findings of the independent scientific peer review panel. The draft technical memorandum for the selection criteria for the metals significance evaluation was distributed to all the stakeholders on April 9, 1996.

A preliminary draft of this report was distributed to key stakeholders in September 1996 at the same time that the report was submitted to the RWQCB for comments. Meetings were also held with these key stakeholders to review their comments on the preliminary draft report. Comments from the RWQCB and key stakeholders have been incorporated into this current draft report. A workshop with all stakeholders is planned to present the Metals Control Measures Plan before it is finalized.

This section presents the results of the metals evaluation and ranking in South San Francisco Bay and stream environments. The objective is to evaluate data from the three receiving water regimes (Bay, transition zone and freshwater) to determine the relative environmental significance of the nine metals in the receiving waters regardless of source. It is possible much of the current conditions in the receiving waters may be due to other discharges not related to current urban nonpoint sources. These issues are addressed in the Metals Source Identification Section (Section 5.0) where probable sources of the *pollutants of concern* are identified.

3.1 SIGNIFICANCE EVALUATION PROCESS

A two part process was used to evaluate and rank the nine metals. The first step involved compilation of recent high quality data for the receiving waters, sediment and tissue (see data sources listed in Section 3.1.1.), and comparison with the evaluation criteria (available regulatory standards and guidelines) to determine the frequency with which individual metals exceed the criteria. The second step involved evaluation of the resultant ranking by the Scientific Peer Review Panel and the use of experience and professional judgment to modify the ranking. This second step was considered necessary in order to account for limitations in the numerical evaluation criteria. This step also allowed other factors not easily adapted to the numerical process to be included. The data evaluation process is described below.

3.1.1 List of Data Sources

Table 3-1 presents the list of data sources used in the evaluation. The data sources have been separated into Bay data and Stream/Upland data depending on the sampling locations. The data consisted primarily of Regional Monitoring Program data, recent bay monitoring data from each of the South Bay dischargers, recent data collected by USGS, and storm water and sediment monitoring data collected by the Program.

3.1.2 Alternative Evaluation Criteria

Several possible options were considered in developing evaluation criteria. The range of possible criteria that were considered included such factors as beneficial use impairment, toxicity testing, human health impacts, aquatic life impacts, and comparison to regulatory chemical criteria. Each of these approaches has advantages and disadvantages and all of the possible approaches are limited by the type, amount, and quality of available data.

After considering the various advantages and limitations of the possible approaches, regulatory chemical criteria were selected as the primary criteria. This allowed evaluation and ranking of each of the individual metals of regulatory concern in the South Bay and stream environments relative to standards set to protect aquatic and marine life and, in some cases, human health. A goal in choosing the evaluation criteria was to develop a set of criteria that would be relatively simple to interpret and understand. Where possible, just one set of criteria or standards were

selected for a given matrix, such as sediments. The use of one set of criteria per matrix avoids problems with interpretation of comparisons to multiple standards which may have been developed in different ways and with potentially different or conflicting meanings. Data compiled for the South Bay environment are compared to the criteria discussed below.

3.1.3 Evaluation Criteria

Water. EPA's interim dissolved water quality criteria and the San Francisco Bay Basin Plan water quality objectives based on total metals were used for comparison of water sample data (EPA, 1995). The EPA's current water quality criteria recognizes that the dissolved form of metals are more biologically available to organisms and are thus a more appropriate measure of potential toxic effects. However, the Basin Plan objectives (based on total metals) are regulatory standards for the Bay Area. The data were compared to both standards however, exceedances of the EPA objectives were weighted more heavily than exceedances of Basin Plan objectives.

South Bay data were compared to the saltwater criteria, while data for streams were compared to freshwater criteria, many of which depend on water hardness. Data collected from the "transition" areas, those areas that transition between the fresh and saltwater, were compared with the lower of the fresh or saltwater criteria for a given metal. For the transition zone, the most restrictive criteria for each of the metals was the saltwater criteria.

To account for potential seasonal differences, particularly in the streams where metals concentrations may be very different during storms than during dry periods, the data were divided into wet and dry season data sets, with the wet season generally defined as November through April. Wet season data for the streams (consisting largely of storm runoff data) were compared with criteria for acute effects while dry season data were compared with criteria for chronic effects. It is more appropriate to compare the storm water flows in streams with the acute criteria as these flows generally last a short period of time as opposed to the longer exposures occurring during dry weather flows. South Bay and transition area data were divided into wet and dry season data sets; however, all data were compared to the chronic criteria regardless of season. Chronic criteria were used for the Bay and transition zones wet season data because the sampling in these regimes was not targeted toward episodic storm events.

Evaluation of the data by season may aid in the source identification studies, although the season that any given exceedance occurred does not weigh in the ranking process as both seasons were given equal weight.

Sediments. California currently has no regulatory standards for sediments. However, the RWQCB has developed Interim Sediment Screening Criteria for wetland creation and upland reuse. The values developed by the RWQCB are based upon a study by Long et al. (1995) which compiled biological effects data and corresponding sediment chemistry data from numerous studies. Sediment data from all three regimes (the South Bay, transition zones and tributary

streams) were compared with the Interim Sediment Screening Criteria for wetland creation cover which are the more conservative criteria in this report (RWQCB 1992). These values take into account the higher naturally occurring concentrations of chromium and nickel in soils surrounding San Francisco Bay and within San Francisco Bay sediments.

The sediment data were also divided into wet and dry season data sets to aid in later source identification, although the season was not given special weight in the evaluation.

Tissues. Tissue burdens are difficult to evaluate in determining an ecological effect. There are standards available to evaluate fish and bivalve tissue burdens for some metals in terms of human health risk due to consumption. For example, EPA has screening level criteria for cadmium, mercury, and selenium in fish tissues. Fish tissue data were compared to these values based upon a fish consumption rate of 30 grams per day as was done by the RWQCB in its study of contaminant levels in fish tissues from San Francisco Bay (RWQCB 1995). The EPA originally used a fish consumption rate of 6 grams per day, however, many environmental organizations expressed concern (CBE, Save the Bay) that this consumption value is too low for the San Francisco Bay region.

Tissue standards are not available for all of the metals of regulatory concern. For metals not covered by the criteria described above, fish, mussel, and clam tissue burdens were compared to various other standards, as there is no single set of standards for tissue in San Francisco Bay. All of the standards used in this evaluation were based on the protection of human health, with the exception of the selenium standard which was based on protection of wildfowl. In general, when several different standards were found for a given metal, the most restrictive standard was used in the evaluation. Because of the wide array of standards, and that the data came from several different species, tissue data were weighted lower than sediment and water data during the ranking process. The tissue data set was not evaluated by season.

Table 3-2 summarizes the selection criteria scheme used in this evaluation while Table 3-3 presents the actual values used for comparison.

3.1.4 Analysis of Exceedances

Data were compiled in electronic spreadsheet format and were sorted by metal, category (Bay, transition zone, freshwater), matrix (water, sediment, tissue), sampling location, and season (wet, dry). Evaluation criteria were used directly (saltwater criteria) or calculated based upon water hardness (freshwater criteria). Exceedance factors (the ratios of the measured concentration to the criteria) were calculated and the total number of exceedances were summed. For each metal in each category, a percentage of exceedances were calculated. The data and results of the calculations are presented in Appendix B of Volume 2.

3.1.5 Application of the Evaluation Criteria

For each media and season (if applicable) the percentage of samples exceeding the evaluation criteria for the nine metals were used to determine the relative rank of the metals. A weighting scheme was used to determine a weighted average percentage of samples exceeding the selection criteria. This was necessary because multiple media and seasons were evaluated and the confidence in the evaluation criteria varied for the different media. Water and sediment data were given the same weight while tissue data were given half the weight of water or sediment.

Weighting of Total and Dissolved Water Criteria. Water data were compared to two evaluation criteria. The percent exceedance for the two criteria for each season/regime (e.g. wet/Bay) were combined to determine an overall water percent exceedance for each season/regime. Exceedances of EPA dissolved criteria were given four times the weight (0.80) of exceedances of the Basin Plan total objectives. This was done to reflect the higher bioavailablity of dissolved metals and the greater confidence in the more recent EPA criteria. For copper in saltwater, exceedances of EPA dissolved criteria and Basin Plan total copper site-specific objectives were weighted equally. This was done because the site-specific objective is thought to be an equally reliable indicator of potential impact as the EPA dissolved standard.

The percent exceedances were totaled for each metal within a season/regime and normalized so that each media/season combination (a total of five combinations) is weighted equally. For example, the percent exceedances for the wet season water data (total and dissolved) represent 20 percent of the total overall score for each metal. This yields a regional weighted average percent exceedance for each metal. Tissue are not summarized individually because the only tissue data which was included are from the Bay regime.

For example, to calcuate the weighted Bay exceedance factor for nickel, we used the following data (also shown in Table 4 in Volume 2):

		Total	Dissolved
Water	wet	31%	7%
	dry	36%	2%
Sediment	wet	2%	0%
	dry	0%	0%
Tissue		0%	

[[(31% x 0.2) + (7% x 0.8)] + [(36% x 0.2) + (2% x 0.8)] + 2% + 0% + 0%]

÷ 5 (regime/season) = 4.5%

All media were used in the ranking process because different metals may affect different media and/or pathways due to differences in chemical and toxicological properties. For example, mercury and selenium are known to bioaccumulate in higher organisms. The chronic mercury water quality criteria was developed based on food chain models and is designed to prevent fish

from accumulating hazardous amounts of mercury. However, the chronic selenium water quality objective does not take into account bioaccumulation. Therefore, for selenium, exceedances of water criteria alone are not necessarily a reliable indicator of potential environmental threat.

3.2 SUMMARY OF RESULTS BY METAL

The overall percent exceedances for each metal were calculated by averaging the exceedances within each regime. The metals were broken into four groups based on overall percent exceedance and summarized in Table 3-4. Mercury and silver are in the first group (> 30 percent exceedance). Copper and zinc are in the second group (10-30 percent exceedance). Lead, nickel, and selenium are in the third group (5-10 percent exceedance). Cadmium and chromium are in the fourth group (< 5 percent exceedance). Results for each metal are discussed below in order of overall rank.

Mercury. Bay mercury concentrations frequently exceeded water, sediment, and tissue evaluation criteria. Similar exceedances of water and sediment were found in the transition zone. In the freshwater regime, mercury in sediment exceeded screening values, particularly in samples collected from Guadalupe Creek watershed, while storm water in streams did not exceed the acute objective or dissolved criteria. Dry weather mercury water concentration in streams could not be compared to the chronic standards because detection limits were higher than the chronic standard. Mercury concentrations in fish tissues from the Guadalupe watershed are known be elevated above the tissue standards, although these are not included in the data tables.

Silver. Silver concentrations in sediment from all three regimes frequently exceeded the screening values. No exceedances were found for water samples. There were no tissue screening values for silver found in the literature.

Copper. Copper concentration frequently exceeded both the Basin Plan site-specific objective and EPA dissolved criteria in the Bay and transition zones. Few exceedances of sediment screening values were found in these regimes. Storm flows in freshwater regimes rarely exceeded the dissolved criteria; however, they frequently exceeded the total metal objective. Sediment screening values were occasionally exceeded in the freshwater regime. Tissue concentrations of copper were below the screening values.

Zinc. Zinc concentrations rarely exceeded water screening values in the Bay and transition zone regimes. Storm flows in freshwater regimes rarely exceeded the dissolved criteria; however frequently exceeded the total metal objective. Sediment screening values were occasionally exceeded in the Bay and frequently exceeded in the transition zone and freshwater regimes. Tissue concentrations occasionally exceeded the screening values.

Lead. Lead concentrations rarely exceeded the water, sediment, and tissue screening values in the Bay and transition zone regimes. Freshwater sediment exceeded the screening values in half

the wet weather samples, although the samples were collected several years prior to and during the phase-out of leaded gasoline. Storm water samples occasionally exceeded the total acute water standards and never exceeded the dissolved criteria. Dry season water samples did not exceed the total objective.

Nickel. Nickel concentrations frequently exceeded total water objectives in the Bay and transition zone regimes. Dissolved nickel in the Bay rarely exceeded water quality criteria. Dissolved nickel in the transition zone often exceeded the criteria. Neither total or dissolved nickel in water exceeded the evaluation criteria in the freshwater regime. Nickel in sediment from all three regimes was generally below the sediment screening values. Nickel in tissues did not exceed the evaluation criteria.

Selenium. Selenium concentrations in water from all three regimes were below both the total and dissolved objectives. Sediment concentrations of selenium were generally below the screening values in the Bay and transition regimes and occasionally exceeded screening values in the freshwater regime. Selenium in Bay tissue occasionally exceeded the U.S. Fish and Wildlife guidelines for protection of waterfowl.

Chromium. Chromium concentrations in water from all three regimes almost never exceeded total or dissolved evaluation criteria. Chromium concentrations in sediment rarely exceeded sediment screening values, with most of the exceedances in the freshwater regime occurring in the upper tributaries of the Guadalupe watershed, an area known to contain serpentine minerals which have enriched chromium concentrations. Bay tissue concentrations were generally below the screening values, with both exceedances found in fish tissues rather than clams or mussels.

Cadmium. Cadmium concentrations in water samples from the Bay and transition regimes never exceeded either the total objective or dissolved criteria. Water samples from the freshwater regime never exceeded the dissolved criteria and only rarely exceeded the total objective. Cadmium concentrations in sediment and tissue never exceeded the screening values.

3.3 SUMMARY RESULTS OF SCIENTIFIC PEER REVIEW PANEL

Members of a Scientific Peer Review Panel were asked to comment on the relative ranking of the metals resulting from the numerical comparison with the evaluation criteria for water, sediment, and tissue. The purpose of the review and comments was to adjust the ranking based on scientific information not easily incorporated into the numerical evaluation process. The following is a summary of the changes to the relative ranking recommended by the Scientific Peer Review Panel during the May 29, 1996 teleconference held to discuss the May 20, 1996 Draft Data Evaluation and Ranking of Metals. The complete draft teleconference record is contained in Appendix A of Volume 2.

1) The metals should be distributed into three classes rather than ranked numerically from one to nine based on our present understanding of the fate and effects and the available data. These classes are:

   - *Pollutants (metals) of Concern*
   - *Pollutants requiring additional investigation*
   - *Pollutants Not of Concern*

Pollutants of concern are those which the weight of evidence suggest an impact is likely occurring or has a potential to occur if sources are not controlled.

Pollutants requiring additional investigation are those which the weight of evidence suggests there is possibly an impact but that there is less confidence in the monitoring data, evaluation criteria, or severity of the impact.

Pollutants not of Concern are those which the weight of evidence suggest there is not an environmental impact occurring in the receiving waters.

2) The Panel recommended the following changes to the relative ranking based on metal specific information:

Selenium. Because selenium is known to have a more severe impact to higher trophic levels due to its tendency to bioaccumulate and biomagnify, exceedances of the tissue screening criteria should be weighted heavily. Results from comparison of bay tissues with U.S. Fish and Wildlife screening concentrations indicate selenium should be placed in the *pollutants of concern* category.

Copper. Exceedances of water evaluation criteria for copper in the bay should be weighted heavily because water samples represent a potentially widespread problem. Also, recent increases in copper concentrations in resident mussels compared to drought year concentrations are of concern. It was noted that the extent to which dissolved organically-complexed copper (one of the major forms of copper in the South Bay) is bioavailable is unclear. For these reasons, copper should be placed in the *pollutants of concern* category.

Nickel. Exceedances of water evaluation criteria in the bay should be weighted heavily because water samples represent a potentially widespread problem. Also, the tendency for nickel to be accumulated into the food chain through phytoplankton bioaccumulation is well documented. The availability of nickel derived from recently disturbed serpentine geologic formations (potentially related to new development activities) is not well understood. For these reasons, nickel should be placed in the *pollutants of concern* category.

Cadmium. Saltwater aquatic life criteria for cadmium were judged to be not reliable based on a review of the literature (Eisler 1985) which indicated sublethal effects occur between 0.5 ug/L and 10 ug/L in marine species. These data indicate the saltwater objective of 9.3 ug/L is too high. Because of the known potential for low levels of cadmium to cause toxicity and the difficulty in measurement of low levels of cadmium, it was recommended that cadmium be placed in the *pollutants requiring additional investigation* category.

The final ranking of the relative environmental significance of each metals is presented below:

Pollutants of Concern	–	Copper, Nickel, Mercury, Silver, and Selenium
Pollutants requiring additional investigation	–	Cadmium, Lead, and Zinc
Pollutants Not of Concern	–	Chromium

Figure 3-1 presents a flow chart that shows the nine metals sorted into the three classes noted above. For *pollutants of concern*, the primary sources of each metal are identified along with controls. For other metal categories the figure presents recommendations with respect to the next steps that should be completed to address the metals.

3.4 RECOMMENDED RESEARCH FOR METALS OF CONCERN

Cadmium, lead, and zinc were placed into the pollutants requiring additional investigation category indicating there are gaps in our current understanding of the fate and effects of these metals within the Bay. In order to help resolve the status of these metals, the following information is needed :

- Cadmium effects levels are not well understood. Further information on the levels of cadmium in water and sediment that are toxic to organisms should be developed to update the currently available toxicity database.
- The dissolved concentrations of cadmium and lead within the Bay are not well understood due to extreme difficulty in obtaining reliable concentration data at the sub-parts per billion levels. Efforts should be supported to develop a reliable database to improve our understanding of the distribution of dissolved cadmium and lead in the Bay.
- Cadmium inputs to the Bay are poorly quantified due to low concentrations and the potential for contamination during sampling and analysis. Better information on inputs to the Bay is needed to confirm that cadmium sources are decreasing similar to trends seen in other metals.
- Lead bioavailability in sediments is poorly understood. Because lead has a high tendency to sorb onto particle surfaces and the largest lead releases occurred in the recent past, the

maximum concentrations of lead occur at some depth in the Bay sediments. Additional information is needed on the bioavailability of sediment lead to adequately determine the potential threat to the environment.

- Specific areas of the Bay are known to be enriched in lead and zinc. Information is needed to determine the effects of these areas beyond the immediate Zone 7 enrichment and to confirm that they are not having a detrimental effect on a large area of the Bay.
- Continued monitoring of all the metals is necessary to confirm that concentrations are trending downwards and to ensure no new sources are introduced due to reformulations of existing products or the introduction of new products.

These research activities are, for the most part, centered on developing a better understanding of the fate, transport, and ecological significance of metals in the Bay. Such activities are the specific charter of the Regional Monitoring Program (RMP), which is supported by the discharge community, including the storm water programs.

This section presents an update of previous metals loading estimates to the South Bay. These updated loads are based on monitoring data collected during 1988-1995 and are used for comparison to the updated point source loads presented in Section 5.0.

4.1 PREVIOUS LOADS ESTIMATES

Loads of metals to the South Bay from tributary streams were previously estimated in 1991 based on two years of monitoring data collected in 1988 and 1989 (Woodward-Clyde, 1991).

Two methods were used to estimate metal loads from the Santa Clara Valley. The first method was based on the relationship between landuse and pollutant loads (Modelling method). The Modelling method used water quality monitoring data collected from catchments with uniform landuse to estimate average water quality specific to residential, commercial, industrial and open areas. The average annual runoff volumes for each landuse were then estimated from the precipitation record using the hydrologic component of EPA's SWMM model. The pollutant loads for each landuse were calculated as the product of the flow and average water quality. Total pollutant loads from each watershed were calculated as the sum of the landuse area loads. Total loads to the South Bay are the sum of loads from each watershed. The second method (Measurement method) used monitoring stations located at the bottom of the watersheds (waterway stations) to represent the water quality resulting from the mix of landuses in the watersheds and stream bank/stream bed interactions. The average waterway water quality was then multiplied with the modeled flow for the entire watershed to calculate a watershed load.

In the Loads Assessment Report, loads from the two methods were compared as a check of the accuracy of the model estimated pollutant loads. Results of the comparison indicated the measured loads were generally higher than the model estimated loads. Factors which may contribute to the higher measured loading include stream bank erosion and variability in open space loads not reflected in the two years of monitoring. To account for these differences, data from waterways which were monitored directly (Calabazas Creek, Sunnyvale East Channel, Guadalupe River, and Coyote Creek), were used to develop a "Correction Factor." The factor is the ratio of the total measured load at all four waterway stations dividied by the modeled load. The correction factors were quite variable for different parameters and ranged from 0.81 (zinc) to 3.64 (TSS).

4.2 UPDATE OF LOADS ESTIMATE

The update of the loads estimate included four steps :

1. For the four watersheds which were monitored during 1988-1995 and for metals loads which were previously estimated in 1991 (cadmium, chromium, copper, lead, nickel, zinc, and TSS), the watershed loads were updated using an update factor which is the ratio of measured

loads based on the 1988-1989 water quality data from the four waterway stations to the measured loads based on the 1988-1995 water quality data.

2. For the unmonitored watersheds an average correction factor was used which was the sum of the average yearly loads from the four monitored watersheds estimated using the 1988-1989 water quality data divided by the loads estimated using the 1988-1995 water quality data.

3. For metals without previous loads estimates (mercury, silver, selenium) the total metals concentration from flow composite samples collected in the four waterway stations was normalized by dividing by the TSS concentration. (Normalization to TSS allows data from a few events to be more reliably used to estimate long-term average concentrations because it removes the variability due to changes in TSS concentration.) The normalized metal concentration for each watershed was then multiplied by the updated total suspended sediment load for that watershed to generate total metal load to the South Bay.

4. For watersheds that were not monitored, the average normalized metal concentration for the four monitored watersheds was used with the watershed specific suspended sediment load.

Table 4-1 presents the mean metals concentrations for the monitored stations for the two monitoring periods. Table 4-2 presents the 1991 and 1996 (updated) loads for the four monitored watersheds, the total loads for all monitored watersheds, and the update factor used for unmonitored watersheds. Table 4-3 presents the updated loads for all watersheds. Figures 4-1a through c present the statistical summary of the TSS normalized metal concentrations by waterway for mercury, silver, and selenium. In general the updated loads are smaller than previously estimated for metals generally thought to have urban nonpoint sources (cadmium, copper, lead, zinc). This may be due to several factors including:

- Annual rainfall during the 1988-1989 monitoring period was below average, possibly limiting the flushing and allowing accumulation of metals to levels which are higher than would be expected during periods of average precipitation, thereby increasing the concentrations of metals in runoff measured during 1988 - 1989 and the corresponding loads.
- Limited monitoring data were used in the 1991 loads assessment (generally less than five events per station) and few estimates of open space water quality were obtained.
- The intensification of existing controls and the initiation of additional controls driven by implementation of the Santa Clara Valley Storm water Program.

TABLE 4-1
COMPARISON OF MEAN CONCENTRATIONS OF RUNOFF FROM MONITORING STATIONS FOR TWO MONITORING PERIODS

Station Type	Stations	Season	Monitoring Period	Cadmium ug/l	Chromium ug/l	Copper ug/l	Lead ug/l	Mercury ug/l	Nickel ug/l	Silver ug/l	Selenium ug/l	Zinc ug/l	TSS mg/l
Stream	S1	WET	1988-1995	1.0	57	52	41	0.3	98	0.2	0.2	215	494
	(Calabazas Creek)		1988-1989	2.2	28	53	63		66			268	190
			* Percent Difference	-55%	102%	-1%	-35%		48%			-20%	160%
Stream	S2	WET	1988-1995	1.4	30	62	67.7	0.3	45	0.2	0.2	255	253
	(Sunnyvale East at Bayshore)		1988-1989	2.3	42	69	64.5		52			337.0	234
			* Percent Difference	-39%	-29%	-11%	5%		-13%			-24%	8%
Stream	S3	WET	1988-1995	0.8	34	36	47	0.4	68	0.3	0.2	144	290
	(Guadalupe River)		1988-1989	1.6	41	79	86		107			294	454
			* Percent Difference	-50%	-17%	-55%	-45%		-37%			-51%	-36%
Stream	S4	WET	1988-1995	1.0	27	33	41	0.2	62	0.5	0.2	129	321
	(Coyote Creek)		1988-1989	3.2	45	66	82		99			263	248
			* Percent Difference	-69%	-41%	-50%	-50%		-37%			-51%	29%

* Percent Difference = ([1988-1995] - [1988-1989])/(1988-1989)

TABLE 4-2
COMPARISON OF LOADS USING 1988-89 and 1988-1995 MONITORING DATA

Station Type	Stations	Season	Ten-Year Average Annual Flow[1] acre-feet	WQ Monitoring Years	Cadmium lbs/yr	Chromium lbs/yr	Copper lbs/yr	Lead lbs/yr	Mercury lbs/yr	Nickel lbs/yr	Silver lbs/yr	Selenium lbs/yr	Zinc lbs/yr	TSS lbs/yr
Stream	S1	WET	5734	1988-1995	15	887	811	639	4	1527	3	2	3344	7685483
			5734	1988-1989	34	440	816	986	no estimate	1029	no estimate	no estimate	4167	2954224
		* Percent Difference			-55%	102%	-1%	-35%		48%			-20%	160%
Stream	S2	WET	1677	1988-1995	6	134	280	308	1	206	1	1	1157	1150737
			1677	1988-1989	10	190	314	293	no estimate	236	no estimate	no estimate	1532	1064096
					-39%	-29%	-11%	5%		-13%			-24%	8%
Stream	S3	WET	28974	1988-1995	63	2654	2804	3685	30	5346	24	13	11285	22757736
			28974	1988-1989	126	3206	6215	6725	no estimate	8438	no estimate	no estimate	23099	35669447
					-50%	-17%	-55%	-45%		-37%			-51%	-36%
Stream	S4	WET	13346	1988-1995	36	960	1191	1492	8	2237	17	9	4685	11619430
			13346	1988-1989	116	1636	2374	2968	no estimate	3565	no estimate	no estimate	9518	8975008
					-69%	-41%	-50%	-50%		-37%			-51%	29%
	Total All Four Streams		49731	1988-1995	121	4635	5086	6124	44	9316	45	25	20471	43213384
			49731	1988-1989	286	5471	9719	10972	no estimate	13268	no estimate	no estimate	38316	48662775
	Loads Update Factor				**0.42**	**0.85**	**0.52**	**0.56**		**0.70**			**0.53**	**0.89**

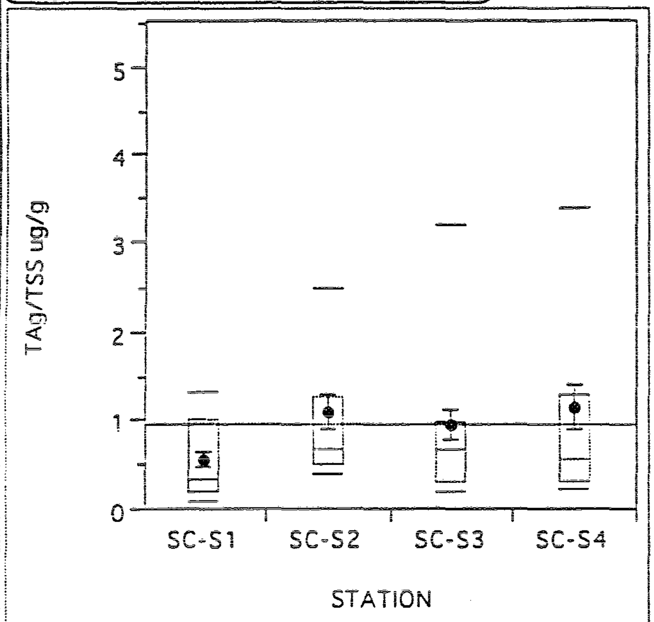
Update Factor = ratio of measured 1988-1995 Loads to measured 1988-1989 loads

[1] From 1991 Loads Assessment (does not reflect hydrology data beyond 1988).

TABLE 4-3
MEAN AVERAGE ANNUAL WET WEATHER LOADS BY WATERSHED
(Based on arithmetic average of 12 years of estimated annual load)

Watershed	Total Area (sq mi)	Flow (acre-feet)	Flow (gallons x 10^8)	Cadmium (lbs/yr)	Chromium (lbs/yr)	Copper (lbs/yr)	Lead (lbs/yr)	Mercury (lbs/yr)	Nickel (lbs/yr)	Selenium (lbs/yr)	Silver (lbs/yr)	Zinc (lbs/yr)	TSS (lbs/yr)
Guadalupe Total (Guad. + L. Gatos)	108	28,974	94.4	172	2,902	4,580	4,955	33	6,425	62	23	17,453	24,248,809
Coyote	123	13,346	43.5	76	1,252	1,767	1,974	9	2,700	26	13	7,914	11,616,850
San Tomas	27	8,005	26.1	63	948	1,500	1,813	8	2,024	12	7	7,509	7,131,147
Adobe, Barron & Matadero	34	7,996	26.1	42	792	1,395	1,375	7	1,837	11	6	3,632	6,172,228
Calabazas	21	5,734	18.7	32	592	1,071	1,068	4	1,377	4	2	2,829	4,388,485
Permamente	18	4,713	15.4	16	336	440	370	4	765	7	4	939	3,837,044
Saratoga	17	5,573	18.2	15	344	365	260	5	776	8	4	623	4,617,076
Sunnyvale East	7	1,677	5.5	10	184	346	350	1	430	1	1	931	1,266,371
Stevens Creek	12	1,545	5.0	9	162	297	298	1	378	2	1	788	1,178,601
Sunnyvale West	5	1,321	4.3	8	145	273	276	1	338	2	1	732	997,327
San Franscisquito	8	1,398	4.6	5	105	145	127	1	240	2	1	325	1,130,500
Total	380	80,282	262	448	7,762	12,179	12,866	75	17,290	137	64	43,675	66,584,438
Loads Update Factor*				**0.42**	**0.85**	**0.52**	**0.56**	**1.00**	**0.70**	**1.00**	**1.00**	**0.53**	**0.89**
Updated Loads				**190**	**6,576**	**6,373**	**7,181**	**75**	**12,140**	**137**	**64**	**23,334**	**59,128,130**

*Update Factor = Ratio of measured 1988-1995 loads to measured 1988-1989 loads.



Quantiles

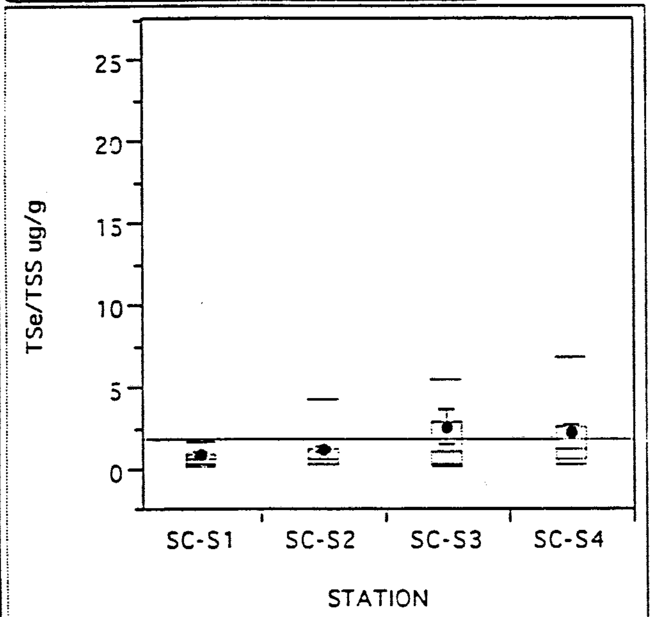
Level	minimum	10.0%	25.0%	median	75.0%	90.0%	maximum
SC-S1	0.0625	0.099034	0.205270	0.342857	1.027778	1.315789	1.315789
SC-S2	0.344828	0.404040	0.512821	0.689655	1.265823	2.5	4.347826
SC-S3	0.117647	0.197318	0.327922	0.669503	0.977273	3.195182	3.333333
SC-S4	0.108696	0.228778	0.317781	0.566239	1.281355	3.4	5.405405

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
SC-S1	18	0.55672	0.45052	0.10619
SC-S2	19	1.10259	0.96295	0.22092
SC-S3	24	0.95792	0.95106	0.19413
SC-S4	28	1.15543	1.33932	0.25311

Project No. 951277NA	Santa Clara Valley Metals Control Measures Plan	SUMMARY OF TSS NORMALIZED METAL CONCENTRATIONS BY WATER WAY FOR SILVER	Figure 4-1a
Woodward-Clyde Consultants			

TSe/TSS ug/g By STATION



Quantiles

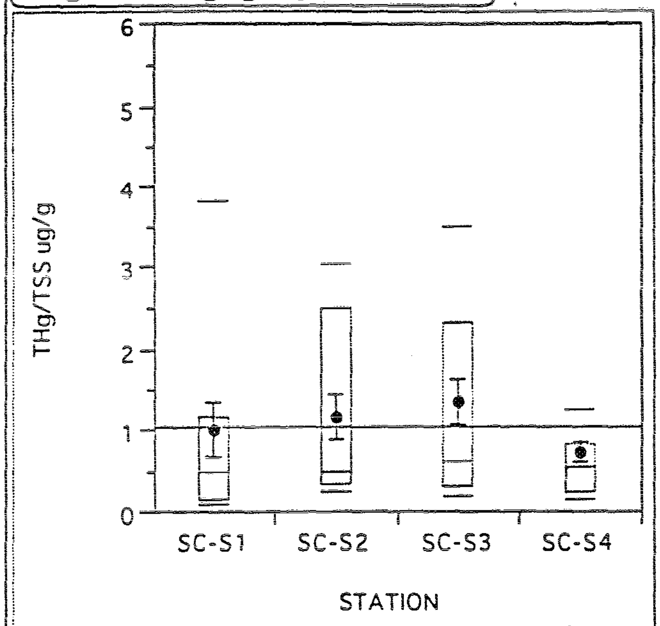
Level	minimum	10.0%	25.0%	median	75.0%	90.0%	maximum
SC-S1	0.103093	0.108135	0.300635	0.548872	0.921818	1.739766	5.555556
SC-S2	0.151515	0.256410	0.377358	0.588235	1.265823	4.183673	4.347826
SC-S3	0.017241	0.127451	0.322368	1.020497	2.856399	5.481013	25.80645
SC-S4	0.12	0.261648	0.623188	1.281773	2.528846	6.769231	14.13043

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
SC-S1	18	0.84083	1.22428	0.2886
SC-S2	19	1.15924	1.22644	0.2814
SC-S3	24	2.56613	5.21877	1.0653
SC-S4	28	2.25089	2.96283	0.5599

Project No. 951277NA	Santa Clara Valley Metals Control Measures Plan	SUMMARY OF TSS NORMALIZED METAL CONCENTRATIONS BY WATER WAY FOR SELENIUM	Figure 4-1b
Woodward-Clyde Consultants			

951277NA-WC-400/082096/graphics/mci



Quantiles

Level	minimum	10.0%	25.0%	median	75.0%	90.0%	maximum
SC-S1	0.068966	0.099680	0.179871	0.494118	1.162281	3.828283	5.555556
SC-S2	0.188679	0.256410	0.344828	0.5	2.5	3.061224	4.347826
SC-S3	0.172414	0.197318	0.318452	0.637175	2.308184	3.508772	5.454545
SC-S4	0.128205	0.172387	0.272147	0.555556	0.833333	1.246667	4.294479

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
SC-S1	18	1.00725	1.43874	0.33911
SC-S2	19	1.15751	1.25339	0.28755
SC-S3	24	1.35003	1.41511	0.28886
SC-S4	28	0.74185	0.79311	0.14988

Project No. 951277NA	Santa Clara Valley Metals Control Measures Plan	SUMMARY OF TSS NORMALIZED METAL CONCENTRATIONS BY WATER WAY FOR MERCURY	Figure 4-1c
Woodward-Clyde Consultants			

951277NA-WC-400/082096/graphics/mci

This section presents an assessment of sources of *pollutants of concern* (copper, nickel, mercury, selenium, and silver) to the Bay. For pollutants requiring additional investigation (cadmium, lead, and zinc), source identification was not conducted, although where data were readily available, information was also included for those metals. The objective of the analysis is to identify significant sources of *pollutants of concern* so that existing controls can be improved or new controls can be developed to reduce the loads to the Bay. Contributing metal sources were categorized into three classes: point sources, nonpoint urban sources, and other nonpoint sources, as shown below.

Point Sources

- POTWs

Nonpoint Urban Sources

- Industrial and commercial
- Commercial pesticide and fertilizer applications
- Construction erosion
- Atmospheric emissions from industrial stack sources and automobile tailpipes
- Automotive (other than tailpipe emissions)
- Water supply

Other Non-Urban Nonpoint Sources

- Mining
- Natural erosion and reservoir spills

The sections that follow examine these sources for their contribution to metals load to the South Bay. For each source, there is a description of the methodology, data sources, results, limitations, and a qualitative estimate of the uncertainty.

Uncertainty Analysis. The load estimates presented in this section were derived using data from various sources. In some cases due to lack of information, parameters were estimated using professional judgment. Additionally, some load estimates were derived using primarily non-detect data and the method detection limit was used for metal concentrations to perform the load estimates. Due to these factors, all of the load estimates have some degree of uncertainty, which depends on the specific methodology and data inputs used to perform the load estimate. The uncertainty of each load estimate was evaluated qualitatively by assigning low, medium and high levels of uncertainty based on the following criteria.

Low- A load estimate with low uncertainty is usually associated with:

- an adequate set of water quality data (e.g., several reliable sampling events)
- adequate flow data
- accurate rainfall volumes.

Data from the POTW monitoring programs generally meet these criteria and are good examples of a source category with low uncertainty.

Medium- Load estimates associated with a medium degree of uncertainty usually result from one or more of the following:

- Lack of the complete data set required to characterize the source (e.g., incomplete inventory of facilities potentially contributing to the load).
- Lack of reasonably recent concentration data, or a limited data set was used to estimate the loads.
- Uncertain information on pollutant pathways, making it necessary to estimate the percentage of pollutant entering the storm drain, runoff coefficients, or sediment yield.
- Uncertainty with respect to extrapolation of data from a specific region for use for the entire study area (e.g., the assignment of representative background metal concentrations for Santa Clara County).

An example of a source category having medium uncertainty is automotive loads because of uncertainty in pollutant pathways.

High- Load estimates were assigned a high degree of uncertainty if several of the above situations were present or if the following criteria was not.

- If most of the data are reported as not-detected, uncertainty is introduced when the method detection limits are used as metal concentrations, and loads are generally overestimated.

An example of a source type with high uncertainty is the loads associated with water that is released over the reservoir spillways; in most cases estimates were based on water quality data that were generally below detection.

5.1 PUBLICLY OWNED TREATMENT WORKS (POTWs)

5.1.1 Methodology/Approach

Three wastewater treatment plants discharge to South San Francisco Bay:

- San Jose/Santa Clara Water Pollution Control Plant (SJ/SC WPCP),
- Palo Alto Regional Water Quality Control Plant (Palo Alto RWQCP), and
- City of Sunnyvale Water Pollution Control Plant (Sunnyvale WPCP).

The treatment plants sample their effluent discharges for metals at least monthly. Metal concentrations and calculated loads are reported in Self Monitoring Reports to the RWQCB. Monthly loads were used to estimate total loading for the wet season (November-April), dry season (May-October), and annually.

5.1.2 Data Source

Monthly average concentrations, total loads and flow data were obtained from the POTWs' 1995 Self Monitoring Reports. Some samples for metals analyses are collected weekly and some samples are collected once a month. The POTWs calculate the mass loading by multiplying the sample concentration by the total flow for the time period the sample represents.

5.1.3 Results

Tables 5-1 through 5-3 present the monthly average concentrations, average flow and mass loading for each POTW. Where sample concentrations were below detection limit, the detection limit concentration was used to calculate loading. Metals with a majority of sample concentrations below the detection limit for all three POTWs are cadmium, chromium, lead, and mercury. Other metals with a majority of sample concentrations below the detection limit for at least two of the POTWs are arsenic, selenium, and silver.

Table 5-4 presents the 1995 annual mass loading for metals, and dry and wet season mass loadings. The dry season is defined as the months of May through October. For all three POTWs, the average daily flow was lower during the dry season. In all cases, the mass loads were lower during the dry season, however, for some metals, especially metals with nondetectable concentrations, the difference between the wet and dry season is not significant.

5.1.4 Limitations of Approach

The assumption that nondetectable results are equal to the detection limit makes the loading calculations for cadmium, chromium, lead, mercury, selenium and silver both very conservative and uncertain. For mercury, a refined estimate was developed by multiplying the 1995 annual flow with the average results form special low-detection limit analyses. These refined estimates are included in footnotes to Tables 5-1 through 5-4. Only 1995 metals mass loadings were presented. Concentrations of various metals in POTW discharges have declined markedly over the past 10 years. The 1995 data best reflects the current state of treatment and source control.

5.1.5 Uncertainty and Methods to Improve Estimate

For cadmium and silver, estimates are based entirely on nondetectable results. Refined estimates for mercury are reported in footnotes to Tables 5-1 through 5-4. Actual loads may be much lower than the estimate given here. For other metals—chromium, copper, nickel, selenium and zinc—estimated loads are probably quite accurate, compared to this report's estimates of loading from other sources.

5.2 INDUSTRIAL SOURCES

5.2.1 Background

Categorical industries operating under the "General Permit to Discharge Storm water Associated with Industrial Activity in Santa Clara County to South San Francisco Bay or Its Tributaries" (RWQCB Order No. 92-011 1992) (General Permit) are required to perform periodic monitoring of storm water runoff. Categorical industries are defined as industries performing one or more processes identified by the Clean Water Act Section 306b and 40 CFR Parts 400 through 471, as significant contributors of pollutants that may compromise water quality. Water quality data and other relevant information collected by industries in compliance with the General Permit have been compiled into a database by the RWQCB, which is available as public information. Monitored parameters include pH, total suspended solids, specific conductance, total oil and grease, total organic carbon, and specific metals of potential concern which are selected based on industrial classifications (SIC). Industries represented in the database include metal finishing, semiconductor manufacturers, and electroplating industries. Non-metal processing industries have been omitted from the data set. Also, the data do not include analyses of unpermitted dry weather discharges, spills, or leaks.

5.2.2 Methodology

Mass loading of metals into the Bay from industrial activities was estimated using the RWQCB's 1992-1995 General Permit storm water monitoring data. As the monitored metal concentrations may incorporate metals from roof runoff and/or atmospheric deposition, the average metal concentrations in the database were adjusted to account for other sources that are not directly related to industrial activity. This adjustment was made by subtracting the mean residential metal concentrations in Santa Clara County, estimated in the Loads Assessment Report (Woodward-Clyde 1991) from the concentration calculated using the industrial database information. Subtracting the concentrations from residential areas is intended to account for metal deposition resulting from tailpipe emissions from gasoline and diesel fueled vehicles and roof runoff, as it is assumed that metals in residential areas predominantly originate from these sources. This "baseline" adjustment is needed to avoid overestimating the loads, and does not eliminate potential facility-generated metal sources. For example, facility runoff exhibiting

elevated metal concentrations, which could be potentially due to facility activities, would still be comparatively high, even after the "baseline" adjustment was performed.

The mean annual runoff was estimated using the impervious area of the industries (supplied by the RWQCB database) and regional rainfall data (SCVWD 1991). Industrial loads were estimated by industrial classification: electroplaters, metal finishers, semiconductors, or other.

5.2.3 Data Sources

Mean metal concentrations were calculated using monitoring data from the RWQCB database for 172 categorical industries in Santa Clara County that discharge to the Bay. The data include industrial storm water monitoring performed from September 1992 through June 1995. The percent impervious area of each industry is also included in the database. As stated above, the industrial metal concentrations were adjusted using residential Santa Clara Valley data obtained from the Loads Assessment Report (Woodward-Clyde 1991). Raw data from the RWQCB database were formatted by B. Grotte of DuPont for his master's thesis, which considered mass loading by industry type (Grotte 1996). The categorical designation used in this report was performed by B. Grotte, and differs somewhat from the SICs used by the RWQCB. In addition, non-metal processing facilities were omitted from the data set. Facilities categorized as "other" include facilities performing a variety of activities, some of which are related to metal processing. An isohyetal map from 1991 was provided by the Santa Clara Valley Water District Flood Control Division. The map was used to estimate the annual precipitation in the region.

5.2.4 Results

Table 5-5 provides the following information:

- The impervious area for each industrial classification
- The number of data points used to calculate the mean industrial concentration for each metal
- The mean industrial concentration for each metal
- The percentage of data points that were reported as not detected (ND) at the sample reporting limit for each metal
- The resulting metal concentration after the "baseline" adjustment was performed
- The estimated load for each metal by industrial classification

Table 5-6 includes the mean residential concentrations for Santa Clara County, as calculated in the Loads Assessment Report (Woodward-Clyde 1991), used to perform the "baseline" adjustment.

The mean industrial concentration was calculated using the method detection limit for concentrations reported as ND.

The mean annual rainfall used to estimate the loads was 13 inches.

The greatest total load contribution from the *pollutants of concern* was from copper, estimated at 693 pounds/year, followed by nickel, estimated at 509 pounds/year. Smaller loads are contributed by silver and selenium, estimated at 201 and 127 pounds/year, respectively. Mercury in industrial storm water contributes a relatively small load to the Bay, estimated at 4 pounds/year.

5.2.5 Limitations of Approach

Factors that may affect these annual mass loading estimates from industrial activities are discussed below:

- The metal concentrations in the database represent industries required by the General Permit to monitor metals in storm water. The General Permit requires monitoring of metals only for industries known to discharge metals, and other industries for which there is reason to believe metals might be present in their discharges. Some industries may not be required to perform storm water monitoring for metals due to their industrial classification. However, the assignment of SICs is subjective and is designated by the manufacturer itself. There may be industries that discharge metals but are not required to monitor storm water for metals due to their SIC. Consequently, the representativeness of the data set may be affected by the assigned SICs.

- Industries for which metal concentrations are reported as ND for two successive monitoring events are not required by the General Permit to continue monitoring for those particular metals. The General Permit does not specify detection limits to be used for the metals analyses, therefore, detection limits vary among analytical methods. Consequently, methods using higher detection limits may report metal concentrations as ND that would be detected if lower detection limits were used.

- As stated in the background information, the data do not include unpermitted dry weather discharges to storm drains or incidents such as spills and leaks.

- The loads were estimated by averaging metal runoff concentrations from all metal processing facilities in the database. This mean concentration was then multiplied by the total industrial flow. The concentration data included some extreme outliers (metal concentrations that were several orders of magnitude higher than the remainder of the data set), which skewed the mean metal concentrations, making them high. The skewed mean

concentration multiplied by the total industrial flow most likely resulted in overestimated loads.

- The industrial metal concentrations were lowered by performing a "baseline" adjustment based on mean residential metal runoff concentrations in Santa Clara County. The "baseline" adjustment introduces a degree of uncertainty in the industrial runoff concentrations and potentially underestimates the loads.
- The monitoring data from the RWQCB data set is for those metal processing industries that implement best management practices. Non-metal processing facilities were omitted from the load estimates.

5.2.6 Uncertainty

The method detection limit was used for metal concentrations reported as ND to calculate mean concentrations. As stated above, detection limits for each metal varied significantly among analyses. The use of the detection limit will affect the average metal concentrations to varying degrees. Relative percent differences (RPDs) between average concentrations calculated using the method detection limit (Method A) and a concentration of zero (Method B) for results reported as ND were calculated to evaluate the effect of using the detection limit for ND results.

RPDs are calculated using the following equation:

$$\text{RPD} = \frac{(\text{Conc. of result A} - \text{Conc. of result B})}{\frac{(\text{Conc. of result A} + \text{Conc. of result B})}{2}} \times 100\%$$

The calculated RPDs for each metal are provided below:

	RPD Between Mean Concentrations (percent)				
Category	Copper	Nickel	Silver	Selenium	Mercury
Electroplaters	7.3	19	89	200	200
Metal Finishers	13	42	141	200	200
Semiconductors	22.2	138	200	200	200
Other	0.8	51	11	200	200

As indicated above, the difference between using the method detection limit and zero as the sample concentration when the sample result is reported as ND has a varying effect on the mean concentrations. RPDs exceeding 50 percent are considered to be significant. Comparing these results to the percent ND for each metal provided in Table 5-5, it is apparent that the difference between the two methods is most significant when the majority of the data are reported as ND, as in the case of selenium and mercury, where the RPDs between the two methods are all 200

percent. If zero was used as the concentration for samples reported as ND, the estimated load would be significantly reduced. The use of the detection limit results in an overestimated load.

In addition, the data set from which the loads were estimated did not include non-metal processing industries. However, non-metal processing industries accounted for a significant portion of facilities in RWQCB's database.

Based on the above consideration, as well as discussed limitations, the quantitative estimate of mass loading from industrial sources is considered to have relatively high uncertainty. However, the order of magnitude of the copper and nickel loads indicate that industrial activities are a significant source of these metals to storm water.

5.2.7 Suggestions for Future Work/Improvement

Most of the uncertainty associated with the loads estimate is due to the fact that detection limits appropriate for storm water are not imposed by the General Permit. A more rigorous estimate could be obtained if minimum quantitation limits were required for storm water analyses.

Industrial activities need to be thoroughly researched by the San Francisco Bay RWQCB so that appropriate industrial classifications can be assigned and non-filers identified. It is also possible that a special study might be performed to confirm the sampling results included in the industrial database.

Non-metal processing facilities need to be included in the load estimates, as they account for a significant portion of industrial facilities in Santa Clara County.

The loads could be calculated more accurately by multiplying the mean runoff concentration from each individual facility by its impervious area. This would reduce overestimating the loads due to a few extreme concentration outliers.

5.3 COMMERCIAL PESTICIDE AND FERTILIZER APPLICATION

5.3.1 Background

Based on information provided by commercial growers and licensed applicators, it is assumed that copper is the primary metal in pesticides and fertilizers, therefore, the contribution of only copper to the Bay was addressed, as other metals are present sporadically or in trace concentrations. Also, this section addresses copper contained in runoff originating from the application of pesticides and fertilizers and does not consider the contribution from erosion of naturally metal-laden soils.

5.3.2 Methodology

The copper load to the Bay from commercial pesticide and fertilizer application was estimated using information regarding total applied pounds of active copper ingredient from two sources: landscape maintenance (golf courses, public and private gardens, etc.) and commercial agriculture. The active copper ingredient in these chemicals was assumed to be copper sulfate ($CuSO_4$). The total mass of copper applied within the study area (excluding Gilroy and Morgan Hill) was estimated using County land use data. The load to the Bay was estimated by assuming that 5 percent of the applied copper mass runs off.

5.3.3 Data Sources

The total mass of active copper ingredient (as $CuSO_4$) applied in the County was obtained from the Santa Clara Valley Nonpoint Source South Bay Copper Reduction Dialogue Progress Report (SCVNPSCP 1994). Commercial pesticide use data are compiled annually by each county and submitted to the State for the California Department of Pesticide Regulation, Annual Pesticide Use Report. The Annual Pesticide Use Report lists all chemicals used by commercial growers and licensed applicators, including pesticides, herbicides and fungicides. The Santa Clara County data estimated the amount of active copper ingredient applied based on known pesticides compositions.

The percentage of the total mass of applied copper within the study area was estimated using landscape and agricultural land use information provided by Santa Clara Valley Water District Benefit Assessment Database (1996), which distinguishes land use by flood zone. Flood zones that drain into the South Bay include North Central, Central, East and North West zones. The South Zone, which includes the cities of Gilroy and Morgan Hill, drains to the south, and was therefore not included in the load estimates. The majority of commercial agricultural activities in the County occur within the South Zone.

The flood zone distribution in Santa Clara County is included in Table 5-7. Landscape maintenance was assumed to be distributed evenly over all flood zones, therefore, the percent of the total area draining into the South Bay was multiplied by the total pounds of copper in pesticides/fertilizers applied for landscape maintenance to calculate the mass of copper applied in the study area.

The commercial agricultural land use area also provided in Table 5-7 includes areas used for orchards, intensive field crops, crops for livestock consumption and flower growers. The percent of the total agricultural area draining into the South Bay was multiplied by the total copper mass in pesticides/fertilizers applied from agricultural products in Santa Clara County.

The percentage of the applied copper that runs off and enters storm water was estimated primarily using professional judgment. This is the result of the limited data available pertaining to pesticide and fertilizer losses in storm water runoff. One study reported annual discharge rates

from golf courses of approximately 1.5 percent to 4 percent for herbicides (Simazin, Oxadiazon) and approximately 1 percent for insecticides (Diazinon) (Sudo and Kunimatsu 1992). Another study pertaining to pesticide runoff from urban lawns indicated that grass turf generally produces modest runoff during most storm events. However, significant pesticide runoff may result if an intense storm occurs shortly after the chemicals are applied (Schueler 1995). A summary review of agricultural pesticide monitoring studies indicated that maximum runoff losses are on the order of 1 percent for water-insoluble pesticides, 2 percent to 5 percent for pesticides applied as wettable powders and 0.5 percent for water-soluble and soil incorporated pesticides. These rates should be considered "worst case" numbers for most urban lawns because grass turf produces less runoff than row crops (Balogh and Walker 1992).

In lieu of copper runoff data, it was assumed that the percentage of applied copper that runs off is comparable to the percentages indicated above for pesticide runoff. Using professional judgment, it was estimated that 5 percent of the applied copper runs off and enters storm water. This percentage assumes that the application did not occur immediately prior to an intense storm event. Moreover, the 5 percent estimate is an average that includes runoff from grassy areas, such as lawns and golf courses, in addition to more barren agricultural land.

5.3.4 Results

Table 5-8 includes the following information:

- the total mass of active copper ingredient (as $CuSO_4$) and copper applied from commercial pesticide/fertilizer products in Santa Clara County
- the total mass of copper applied in the study area, calculated by multiplying the total applied in Santa Clara County by the percentages of the total and agricultural land use area draining to the South Bay (as calculated in Table 5-7)
- the copper load to storm water, assuming that 5 percent of the total copper applied runs off

The total copper load from commercial pesticide and fertilizer application was estimated at about 74 pounds/year.

5.3.5 Limitations of Approach

Factors that may affect the copper load estimates are discussed below:

- The total mass of active copper ingredient estimated in the Copper Reduction Dialogue was an estimate for the entire County. The copper mass in the study area was estimated using appropriate land use data, however, it was assumed that landscape maintenance was equally distributed throughout all the flood zones. The copper mass was estimated assuming the active ingredient to be copper sulfate.

- Knowledge of homeowner purchase and usage is uncertain due to insufficient data. Consequently, the estimated copper loads were based only on information that commercial growers and licensed applicators were required to submit to the County. The lack of information results in an underestimated mass of applied copper.
- Due to lack of available information, the percentage of applied copper that runs off was estimated using professional judgment. Runoff volumes depend on irrigation practices (control of runoff, or recycling of irrigation water), vegetation, rainfall and the method in which the chemical is applied (spraying versus application of solid granulated product). An average runoff of 5 percent was assumed for the entire study area.

5.3.6 Uncertainty/Suggestions for Future Work

Based on the above limitations, the copper load due to commercial pesticide and fertilizer application is considered to have medium uncertainty. This load does not estimate the total contribution resulting from the application of these chemicals. The homeowner contribution could not be estimated due to unavailable data for private product consumption, sales and volumes.

Very little information is available regarding metal runoff from lawns and agricultural fields. Some runoff water quality studies are currently being conducted (U.S. American Golf Association, Meadows Gold Club, and Allendale Michigan), however, these studies are primarily concerned with organic constituents or nutrients in pesticides. Metal data are unfortunately lacking; this is an obvious area where more studies need to be performed, as well as an improved assessment of private homeowner product use and consumption in Santa Clara County.

5.4 EROSION (NATURAL AND CONSTRUCTION SITE) AND RESERVOIR SPILLS

5.4.1 Background

Natural erosion refers to erosion caused by elements unrelated to human activity. Erosion is affected by rainfall intensity, soil erodibilty, slope length and steepness, vegetation and best management practices (BMPs) (Forrest and Harding 1994). Sources of natural erosion include range and forest land, stream channel beds and banks, flood plains, and gullies. Erosion sources related to human activity include agricultural land, road banks and ditches, spoil piles, graded areas and construction sites (Forrest and Harding 1994). Erosion of mineral deposits in surficial soils results in transport of metal-laden sediment into nearby streams, where it either settles or is transported into the Bay.

This section also includes estimated loads from unregulated reservoir spill events. The reservoirs themselves should not be considered as a source of metals to the Bay. However, eroded sediment from natural and human activity-induced sources accumulates in the reservoirs and can

be transported into the Bay during spill events. Loads from reservoir spills have been reported on an annual basis, however, spills only occur during years of high precipitation. The years in which spill events occurred are provided in this section for each reservoir. The flow volumes were measured at gages below the reservoirs and do not include flows attributed to managed releases (which are performed to fill infiltration basins and recharge aquifers). It is assumed that almost none of the managed releases reach the Bay.

5.4.2 Methodology and Data Sources

The load into the Bay due to erosion was estimated using the total suspended solid (TSS) loads calculated in Section 4.0. The TSS loads were multiplied by upland sediment metal concentrations (mass of metals/mass of sediment) from Calabazas Creek, to estimate the total erosional load of each metal. Limited data are available on background metal concentrations in soils in Santa Clara County. Metal concentrations vary with soil type throughout the County, thus it is difficult to assume representative background metal concentrations for the entire study area. In lieu of more comprehensive data, dry-weight metal concentrations from upland stations on Calabazas Creek were chosen as representative of background concentrations for the study area (SCVWD 1994). The resulting estimate includes all sources, i.e., construction site, agricultural and mining activity erosion, in addition to natural erosion. The mining contribution (for mercury) is discussed separately in the section on Mining Sources. The following described how individual contributions to the total erosional load were estimated.

The load due to construction erosion was estimated using the RWQCB Construction Notice of Intent (NOI) Database. The total acres under construction in the study area were estimated using the database, which provides information on the total area under construction and duration of construction activity. The annual acres under construction were estimated using the following methodology:

- For construction activity exceeding one year, the total number of acres were divided by the duration of activity to obtain the number of acres under construction per year that may be subject to erosion.

- If the duration of construction activity was less than one year, the acres subject to erosion were apportioned based on the number of rainy season months in which the activity occurred, because minimal erosion is assumed during dry weather. The rainy season months are generally considered to be November-April; dry season months are generally considered to be May-October.

- The average number of acres under construction were estimated by adding the total acres (per year) for all construction activity ending in a particular year (e.g., summing acres (per year) for all sites in which construction ended in 1993). The average acres per year

under construction were estimated using the average acres per year for construction activity occurring during 1992-1998.

- Professional judgment was used to estimate rainy season sediment yield from construction sites. It was assumed that the sediment yield was 5,000-10,000 pounds per acre per year which is equal to 41 to 83 cubic feet per acre per year. The sediment yield estimate was provided by an individual who is considered to be an expert on erosion and sediment control (Forrest 1996). An average of 7,500 pounds (62.5 cubic feet) per acre was used to estimate the total sediment yield.
- The sediment yield was multiplied by the background metal concentrations to estimate the load contribution for each metal.

The metal loads from construction sites were subtracted from the total loads to estimate the load assumed to result primarily from natural erosion. The land area used for agriculture in the study area accounts for only about three percent of the total land area (estimated using SCVWD Benefit Assessment Database, 1996), however the contribution of erosion from those areas was not investigated for this report.

Reservoir release loads were calculated for six reservoirs operated by the SCVWD:

- Stevens Creek Reservoir,
- Lexington Reservoir,
- Guadalupe Reservoir,
- Almaden Reservoir,
- Calero Reservoir, and
- Anderson Reservoir.

The reservoir spill flows were derived using 1976-1990 hydrology information provided by the SCVWD. Flows for all releases, including managed releases were provided, and flows due to spill events were obtained using hydrographs, which documented the dates in which the spill events occurred.

No flow data were provided for Lexington Reservoir for 1983-1985. Hydrographs (storage in acre-feet per day for each reservoir) indicated that spills occurred in 1983, therefore the total flow for this year had to be estimated. The average flow rate (per day) of all spill events that occurred between 1976-1990 for Lexington Reservoir was multiplied by the number of days that spills occurred in 1983 (provided by the hydrograph), to estimate the total flow from spill events in 1983. Data were provided for all other years in which spills occurred.

Metal concentration data from 1988 and 1994 sampling events of the reservoir releases were provided by the SCVWD. Data from 1988 were used to calculate the loads, as discussed below.

Loads were estimated by multiplying the total spill volume flow by metal concentrations detected for each reservoir. The method detection limit was used for metal concentrations reported as not-detected.

SCVWD provided metals concentration data from routine monitoring of their reservoirs during 1994. In addition, analysis from a 1988 sampling was available and utilized.

5.4.3 Results

Table 5-9 includes the number of construction sites with activity ending in a particular year and the average number of acres under construction per year. The number of acres under construction per year was estimated to be 323 acres.

Table 5-10 includes the following information:

- Average background metal concentrations
- Estimated loads from all erosion sources
- Estimated loads from construction sites
- Estimated loads from natural erosion

The greatest total load from metals is from nickel, estimated at about 4,800 pounds per year, followed by copper, estimated at about 2,300 pounds per year. A relatively significant load is contributed from lead, estimated at about 700 pounds per year. Relatively smaller loads are contributed from selenium and mercury, estimated at about 12 and 4 pounds per year, respectively. The silver load was not estimated, as the Calabazas Creek sediment data did not include silver analyses. Erosion from construction sites appears to contribute a relatively small percentage of the load compared to natural erosion.

The relatively high background nickel and copper soil/sediment concentrations are most likely due to their association with metallic minerals in the County. Pyrrhotite ($Fe_{1-x}S$) is an iron sulfide mineral that contains small amounts of nickel and is reported to occur in the County (Davis and Jennings 1954). The largest known copper mineral deposits occur in the Hooker Creek mine, which is located 7 miles south of Los Gatos, although these minerals have also been found throughout the central Coast Ranges (Davis and Jennings 1954) and in the New Almaden District (Bailey and Everhart 1964). Most copper-containing minerals are associated with serpentine or igneous rocks of the Franciscan formation and include malachite ($Cu_2CO_3(OH)_2$), azurite ($Cu_3(CO_3)_2(OH)_2$), limonite ($FeO(OH)\cdot nH_20$), chalcopyrite ($CuFeS_2$) and pyrite (FeS_2) (Davis and Jennings 1954).

Flows attributed to reservoir spill events and the years in which spills occurred are provided in Table 5-11. All samples from SCVWD's routine reservoir monitoring during 1994 yielded nondetectable results at the detection limits used. The samples collected at the six reservoirs over two days in February 1988 were analyzed at lower detection limits, so these data were used in estimate the loads. Table 5-12 also shows the metal concentrations used to estimate the loads and the metal load from each reservoir.

5.4.4 Limitations of Approach

Factors that may affect the load estimates from erosion sources and reservoir spills are discussed below:

- A small data set of metal concentrations from one watershed were considered to be representative of background metal concentrations in the entire study area. Soil concentrations representative of the study area are not easily obtained due to variation in soil types (silt, clay) and the distribution of mineral deposits throughout the County.
- Silver data were not included as part of the Calabazas Creek background soil/sediment concentration study. It is not assumed that silver does not naturally occur in soils in the County, however, loads are uncertain due to the absence of data. Silver has been reported to occur with copper minerals and gold adjacent to Hooker Creek and was mined commercially between 1936-1939 (Davis and Jennings 1954). Therefore, silver loads from erosion sources should have been considered.
- An average sediment yield of 7,500 pounds per acre was used to estimate the total annual sediment yield from construction sites. The amount of erosion resulting from construction activities strongly depends on erosion control measures (BMPs) that must be implemented at the sites. The sediment yield was not adjusted to account for erosion control measures employed at the sites (very little information regarding BMPs were included in the database).
- The contribution of erosion from agricultural land was not investigated for this report. Therefore, the load estimated from natural erosion may also include erosion from agricultural activities.
- Since the loads from construction sites were estimated based on the construction sites in the RWQCB Construction NOI database, the analysis does not take into account loads from sites less than 5 acres. On account of this, the loads may be underestimated by about 10 percent.

5.4.5 Uncertainty

Based on the above considerations, the estimated loads from construction site and natural erosion is considered to have medium uncertainty. The primary uncertainty originates from the background metal concentrations used to calculate the loads and the fact that site-specific control measures were not used to estimate sediment yield from the construction sites. Moreover, the load from natural erosion was obtained indirectly, by subtracting the estimated yield from construction sites from total sediment yield. However, the magnitude of the copper and nickel loads suggest that erosion is a significant source of these particular metals.

Concentrations for cadmium, mercury and selenium were assumed equal to the detection limit. Average concentrations for the remaining metals are based on only one data point for each reservoir. The concentration data is eight years old; current concentrations may differ, particularly for lead. The reservoir flow data are only estimates of the actual reservoir release flows. Flows from reservoir releases may be somewhat different from those recorded at downstream monitoring stations because of added runoff, infiltration into the stream bed, outflow from the stream bed and use of streams to convey imported water.

Loads from reservoir spills are considered to have medium uncertainty. Only one set of metal concentration monitoring data was used to estimate the loads. In addition, estimated flow volumes may not fully represent flows to the Bay, because the flow measured at gages below the reservoirs may not include infiltration and outflow within the stream bed, added runoff and other factors.

5.4.6 Suggestions for Future Work/Improvement

Metal concentrations in Santa Clara soils and sediments need to be better delineated. Soil samples should be analyzed at the urban boundary within each watershed to obtain more representative background metal concentrations.

An improved estimate of natural erosion sediment yield could be obtained using a direct method, such as an empirical predictive equation like the Flaxman Method. The Flaxman Equation evaluates sediment yield based watershed characteristics including precipitation, slope, temperature, particle size distribution, clay content in soils and storm event peak discharge rates. However, this method does not consider gully and channel erosion, so these sources would have to be included. The amount of sediment transported downstream could be estimated by taking into account the flushing characteristics of the South Bay. Also, an estimate using Flaxman Equation would require additional data and modeling and was considered beyond current scope of work.

An improved estimate of the erosion from construction sites could be obtained using the Universal Soil Loss Equation. Erosion could be calculated on a per-site basis using characteristics including site area, slope length and gradient, soil types, rainfall, cover,

conservation practices and duration of construction (months in rainy season). The amount of sediment transported to surface water bodies could then be estimated by evaluating the site proximity to streams and drainage system efficiency.

To improve the estimate of the contribution of reservoir spill flows to metals loads in the downstream watershed, repeated sampling, at appropriately low detection limits, should be done at spillways during releases. Analysis of these samples should include measurement of total suspended solids (TSS); it may be possible to correlate concentrations of many significant metals to TSS. This could simplify ongoing work.

5.5 INDUSTRIAL STACK AND TAILPIPE EMISSIONS

5.5.1 Background

Tailpipe exhaust from diesel and gasoline-fueled vehicles and emissions from stationary point sources (industrial stack emissions) were identified as the two major sources of metals in the atmosphere that contribute to nonpoint source contamination. These sources contribute indirectly to runoff pollution by affecting the quality of rainfall and dryfall (settling of pollutants associated with atmospheric particulates). Only total emissions to the atmosphere are considered in this section as opposed to load estimates, as the percentage of metals that deposit and enter the Bay is uncertain.

5.5.2 Data Sources/Methodology

A literature review of journal articles and environmental pollution publications was conducted to evaluate the extent to which motor vehicle exhaust contributes to atmospheric metal levels. In addition, two emissions inventories published by the California Air Resources Board (CARB), Emission Inventory 1993 (1995) and BURDEN7F: Methodology for Estimating Emissions from On-Road Motor Vehicles (1993), were reviewed for information on mobile source emissions. Information regarding metal concentrations in particulate emissions was obtained from Air Emissions Species Manual, Volume II: Particulate Matter Species Profiles (EPA 1990). Two other inventory reports were also reviewed for information on chromium and nickel — the Revised Motor Vehicle Emission Inventory of Total Chromium (CARB 1987a) and Nickel Emission Inventory Draft Report (CARB 1987b). These inventories provide estimates of total particulate emissions.

Stationary point sources in Santa Clara County were identified in the Bay Area Air Quality Management District's (BAAQMD's) Toxic Air Contaminant Control Program (BAAQMD 1995). This document is an annual compilation of air toxic contaminants that are reported in compliance with AB2588 legislation, which requires sources of certain levels of toxics to disclose the type and amount of toxics emitted from the facility.

Using the above data sources, metal emissions from stationary point and mobile sources were compiled for Santa Clara County. Stationary sources from other locations in the Bay Area generate significant emissions and therefore could affect metal levels in Santa Clara County, depending on meteorological conditions (wind direction, wind speed, stability) that affect metals transport. The extent to which transport from other counties contributes to Santa Clara County atmospheric concentrations was not analyzed for this study because such an analysis would likely require extensive review of sources in surrounding counties and dispersion modeling of each source.

Specific methodologies used to estimate the loads for individual metals are provided below:

5.5.3 Nickel and Chromium

Emission factors (e.g., pound of metal in exhaust per vehicle mile traveled) for chromium and nickel were obtained from the CARB Emissions Inventory Branch. Chromium emissions are summarized in a motor vehicle emission inventory of total chromium compiled by the Mobile Source Division (CARB 1987a). Nickel emissions are summarized in an emission inventory compiled by the Technical Services Division (CARB 1987b).

An estimate of daily vehicle miles traveled in Santa Clara County was obtained from CARB based on the 1994 output from BURDEN7F, which is a computer program that estimates emissions from motor vehicles (CARB 1993). The number of vehicle miles traveled were divided into groups of mobile sources, such as light-duty gas and diesel autos, medium-duty trucks, and heavy-duty gas and diesel trucks.

Emissions in Santa Clara County of chromium and nickel were estimated by multiplying the emission factor for the specific fuel type (unleaded gas or diesel), in grams per vehicle mile traveled, by the estimate of vehicle miles traveled for a specific vehicle type and fuel, e.g., heavy-duty diesel truck.

Chromium and nickel emissions were also estimated using the BURDEN7F particulate matter values with the EPA speciation for chromium and nickel. Although the CARB is the source for the two estimates, (i.e., the emission inventories from 1987 and the BURDEN7F model), the resulting emission estimates are different. This is because the 1987 data are from studies of nickel and chromium sources and measurements of their emissions, whereas BURDEN7F is a model that predicts emissions based on the vehicle miles traveled for each county's vehicle fleet.

5.5.4 Copper, Mercury, Silver, Selenium, Zinc and Lead

Emissions were estimated using particulate matter emissions data and speciation profiles of particulate matter. Particulate matter emissions were obtained from the 1994 BURDEN7F output. The speciation profiles were obtained from Air Emissions Species Manual, Volume II:

Particulate Matter Species Profiles (EPA 1990). The EPA speciation data for lead do not reflect the 1992 lead phase-out in fuel. The BURDEN7F emissions data show zero for lead, as opposed to older data from 1991, which still showed about 40 pounds per day of lead in Santa Clara County (CARB 1992).

Several speciation profiles are provided for each fuel and vehicle type, depending on the method used to derive the data. In most cases, a composite of speciation profiles is provided and was used. For light-duty passenger vehicles, the composite profile provided was for leaded and unleaded fuel and was not used. Instead, an average of the three unleaded profiles was used to obtain a composite profile of unleaded fuel for light-duty unleaded passenger vehicles. Speciation profiles were available for light-duty unleaded vehicles, light-duty diesel vehicles, and heavy-duty diesel trucks. The percent weight of each metal in total suspended particulate matter was multiplied by total particulate matter emissions from mobile sources in Santa Clara County to estimate motor-vehicle emissions.

5.5.5 Results

Table 5-13 presents emission estimates from each vehicle and fuel type, e.g., light-duty diesel auto, heavy-duty gas truck. Emission estimates by fuel type are summarized in Table 5-14. Emissions in pounds per year are presented for stationary point sources in Santa Clara County and for the entire Bay Area. For motor-vehicle exhaust, emissions are summarized for unleaded fuel and diesel fuel. Note that Table 5-14 provides two estimates of chromium and nickel from mobile sources based on two different estimating methods. The estimates from the two methods are in general agreement for chromium, however the nickel estimates vary significantly. As there are no data to indicate which nickel estimate is better, it is recommended that an average of both numbers be used.

Of the three atmospheric sources investigated (stationary point, diesel-fueled vehicle exhaust/gasoline-fueled vehicle exhaust), diesel-fueled vehicle exhaust appears to be the primary contributor of metals into the atmosphere. Total loads from tailpipe emissions (including both diesel and gasoline-fueled vehicle exhaust) of *pollutants of concern* are 116 lbs/year of copper, 58 lbs/year of nickel, 51 lbs/year of silver, 32 lbs/year of mercury and 58 lbs/year of selenium. Nickel is the only problem metal in industrial stack emissions, with a load estimated at approximately 21 lbs/year.

5.5.6 Limitations of Approach

Factors that may affect the load estimates are discussed below:

- Mobile source emissions were estimated using two databases from different years: BURDEN7F particulate matter data from 1994 and speciation data from 1990. The same

is true of the chromium and nickel inventories from 1987 that were used with the BURDEN7F 1994 data.

- Emission estimates for lead do not reflect the 1992 phase-out of lead in fuel. Estimates are therefore assumed to be high.

5.5.7 Uncertainty/Suggestions for Improvement

Based on the above limitations, the vehicle exhaust emission estimates are considered to have medium certainty. This is because the speciation data and the CARB chromium and nickel inventories were not necessarily developed for use with particulate matter emissions to estimate vehicular exhaust emissions. In addition, the percentage of those calculated emissions that enters the Bay cannot be ascertained.

The industrial point sources emissions are presented with low uncertainty because they are compiled annually by the BAAQMD from information provided by permitted facilities. However, the portion of point source emissions entering the Bay cannot be confidently estimated either.

Metals are present in exhaust emissions partly from automotive engine wear and corrosion, and partly because there are trace metals in the fuel. Further research would be required to estimate what portion of the metals in exhaust emissions are attributable to each of the above components. In addition, the percentage of the total emissions that enter the Bay requires further study, so that loads may be estimated.

5.6 AUTOMOTIVE SOURCES

5.6.1 Background

Automobiles have been identified as a source of storm water pollution, owing to metals present in brake pads, tires, motor oil and coolant (Woodward-Clyde 1992; Woodward-Clyde 1994). Brake pads and tire wear, in addition to leaks and illegal dumping of motor oil and coolant are the primary automotive sources of metals in storm water.

5.6.2 Methodology

The loads estimated in the Source Identification and Control Report (Woodward-Clyde 1992) and Contribution of Heavy Metals to Storm water from Automotive Disc Brake Pad Wear (Brake Pad Report) (Woodward-Clyde 1994) were used in this report. The loads were not updated because most recent information regarding the total number of automobiles (includes cars and trucks) registered in Santa Clara County indicated an increase of only 5 percent since 1992, when the original estimates were made (DMV 1995). Moreover, updated metals concentrations for

tires, coolant and motor oil could not be obtained due to the lack and/or proprietary nature of the product information.

The detailed approach used to estimate the mass loading of metals into storm water from automotive sources may be found in the individual reports (see references for full citation). Loads were estimated using information acquired through literature reviews, phone surveys with knowledgeable individuals (e.g., professional oil changers, antifreeze manufacturers, brake pad manufacturers, etc.) and professional judgment. Brake pad concentrations were evaluated through analytical testing of a small population of brake pad models used in Santa Clara County (although approximately 79 percent of the automobiles owned in the county are produced by these specific manufacturers). Table 5-15 provides a summary of the methodology, inputs and data sources used to estimate the loads from each automotive source.

5.6.3 Results

The annual mass loadings for metals are provided in Table 5-16. Loads of copper and zinc from brake pads and tires appear to represent the most significant automotive source of metals into storm water, at approximately 8,000 and 33,800 pounds/year, respectively. Relatively smaller loads are contributed from nickel, lead and cadmium, estimated at about 100, 480 and 230 pounds/year, respectively. Brake pads, tires and illegal dumping of motor oil appear to be the most significant sources of automotive-related metals in storm water.

5.6.4 Limitations of Approach

Factors that may affect load estimates from automotive sources are discussed below:

- Some metal concentrations used to estimate the loads were from relatively outdated sources, such as the coolant and motor oil concentration data from 1975 (Shaheen 1975). Older data were used because the product information is often proprietary and therefore could not be easily obtained.
- Loads were estimated by assuming a certain percentage of what is dumped or deposited on streets and highways enters the storm drain. Due to lack of available data, professional judgment was used to evaluate transport pathways of metals into storm water.
- The tire concentrations used to estimate loads from tire wear only considered cadmium and zinc. Earlier tire concentration data indicated that lead, chromium copper, nickel and zinc were also present in tires (Shaheen 1975). However, the earlier data reported by Shaheen are most likely not representative of contemporary tire compositions, considering recent developments. Moreover, the 1990 data reported by Radian that was used for the estimate may also be biased high.

- Brake pads samples used in this investigation, represented about 12 percent of the brake pad models used in Santa Clara County, however, the metal concentration data were assumed to be representative of all the brake pads used in the County. Load estimates may be affected if more brake pad models were analyzed. Furthermore, more recent information obtained from the Brake Pad Partnerships indicated that manufacturers are currently using more copper in brake pads than indicated in older data (Moran 1996).

5.6.5 Uncertainty

Based on the above considerations, the quantitative estimate of mass loading from automotive sources is considered to have medium uncertainty. Higher certainty is associated with the brake pad concentrations, as these concentrations were determined using appropriate EPA test methods, albeit a relatively small brake pad population was analyzed. The primary uncertainty originates from lack of current metals data for tires, motor oil and coolant. Additionally, the transport pathway of metals into storm water from automotive sources is uncertain. In the absence of specific data, it was assumed that 55 percent of all brake pad dust makes its way into the bay. Although there is some uncertainty associated with the loads estimate, the order of magnitude of the estimated loads indicates a significant contribution of metals to storm water from automotive sources.

5.6.6 Suggestions for Future Work

Much of the uncertainty associated with the loads estimate is due to lack of concentration data for tires and fluids that may contain metals due to their contact with metallic engine parts. Brake pad and tire rubber composition is considered proprietary information by the manufacturers and hence cannot be easily obtained. Most available data in the literature are outdated. Concentration data need to be more readily available in light of the significant metal contribution from automotive sources. In addition, the fate of metal pollutants from their deposition onto roads, or improper disposal, should be further investigated.

5.7 WATER SUPPLY SOURCES

5.7.1 Methodology/Approach

Potable water supply becomes a nonpoint source of pollution when it is discharged to storm drains. Typical pathways include car washing, over-irrigation, building and sidewalk cleaning, system overflows or hydrant flushing. See Figure 5-1. The amount of potable water that is discharged to storm drains annually has previously been estimated as 10 percent of the difference between potable water deliveries and POTW influent flow (SCVWD 1992).

Within the watershed, potable water is supplied by the wholesale agencies including Santa Clara Valley Water District (SCVWD) and the San Francisco Water Department (SFWD), with retail deliveries by local groundwater purveyors and local surface water purveyors.

Metals in potable water originate from the following major sources:

- raw surface and groundwater supplies (As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn)
- copper sulfate addition for algal control (Cu)
- zinc orthophosphate corrosion inhibitor (Zn)
- corrosion of plumbing materials (Cu, Pb)

Previous work (see Section 5.7.2) has estimated how each of these metals sources affects water "at the tap." This estimate required a sequential accounting of additions and removals during water treatment and distribution. For example, copper sulfate (an algaecide) is added to some reservoirs, but much of that copper is subsequently removed during water treatment. By contrast, corrosion of copper pipes and solder contributes directly to copper "at the tap." In addition, the SCVWD adds copper sulfate to some groundwater recharge facilities.

The overall metals load to storm water is calculated from estimates of each source and estimates of the proportion of total potable water deliveries that reach the storm drains.

5.7.2 Data Sources

The SJ/SC WPCP service area water consumption was obtained from the San Jose Environmental Services Department (Van Curren 1996). POTW 1995 influent flows were obtained from Self Monitoring Reports.

The City of Sunnyvale's *1995 Annual Pretreatment Report, Appendix E: Update of Source Loadings to the WPCP*, contains 1995 concentration data from samples at city turnouts, total service area water consumption, and percentage from each wholesale water supply source. Contributions from the wholesale water supply for the Palo Alto RWQCP service area were estimated from City of Sunnyvale sample concentration data and percentages of wholesale water supply sources documented in the *Copper and Selenium in Water Supply of the Santa Clara Valley* (Copper and Selenium Steering Committee, January 1994). The report, *Residential Sampling Program for the San Jose/Santa Clara Water Pollution Control Plant* (February 1993) contains data on metals concentration of samples taken from hydrants in that service area. Water supply concentration data were also collected from the *SCVWD 1994 Water Quality Data* report.

Estimates of the effects of DWR copper sulfate dosages to the South Bay Aqueduct (SBA) on tap water were obtained from the report *Copper and Selenium in Water Supply of the Santa Clara Valley* (Copper and Selenium Steering Committee, January 1994) and from the DWR (Joyce

1996). For SFWD copper sulfate dosing, recent sample data were obtained from the SFWD (Dingman 1996).

Information on zinc orthophosphate dosing was obtained from the SCVWD 1994 Annual Water Quality Report. *Copper and Selenium in Water Supply of the Santa Clara Valley* (Copper and Selenium Steering Committee, January 1994) contains estimates of how corrosion of plumbing materials contributes to tap water copper concentrations in each of the watershed's three POTW service areas. Additions of lead from corrosion were estimated here using data from 1992 Sunnyvale tap water samples.

5.7.3 Results

The loading estimates were prepared as follows:

1. Calculation of flows to "outdoor" uses (10 percent of this amount assumed to enter storm drains.
2. Summary of concentrations at turnouts to retailer's water distribution systems at this point, the water supply includes contributions from algicides and corrosion inhibitors.
3. Calculation of estimated contributions from corrosion inhibitors.
4. Calculation of estimated contributions from corrosion of plumbing materials.
5. Summary of contributions from all sources, and estimated total loading from potable water source.

Flows to "Outdoor" Uses. Table 5-17 presents the potable water consumption, POTW influent flow data and the difference of these values. This latter amount represents "outdoor" uses, mostly for irrigation. Ten percent of water used outdoors, or 2,174 mgy, was assumed to reach the storm drain by one pathway or another. As part of the Program's effort to develop a Utility Performance Standard, outdoor water usage associated with water utility operation and maintenance activities is being estimated (Beau Goldie private communication, Feb. 4, 1997). This effort is a step towards improving the ten percent estimate.

Concentrations at Turnouts and Copper Contribution From Algicide. In 1995, the City of Sunnyvale collected samples at turnouts selected to represent groundwater, SCVWD water, and SFWD water. These samples were analyzed at lower detection limits. Even at the lower detection limits, the majority of samples (>75 percent) for arsenic, lead, mercury, selenium, and silver were nondetectable (see Table 5-18).

In 1992, hydrants in different portions of the SJ/SC WPCP service area were sampled to represent the mix of the actual delivered water supply. Table 5-19 represents the contribution of

metals from water taken at the turnouts to the local retailers' distribution system based on these two data sources.

The report, *Copper and Selenium in Water Supply of the Santa Clara Valley* (Copper and Selenium Steering Committee, January 1994), found that SCVWD's Penitencia and Rinconada treatment plants removed approximately 94 percent of the copper with which DWR periodically doses the South Bay Aqueduct (SBA). (Copper sulfate was added on 13 days in 1994 and 2 days in 1995.)

The SFWD applies copper sulfate to the Calaveras and San Antonio Reservoirs. These reservoirs are treated by the Sunol Valley Filter Plant (SVFP) before distribution to the South Bay water retailers. The SFWD recently decreased the applied dosage of copper sulfate to the reservoirs. The two most current applications of copper sulfate, October 24, 1995 and May 1-2, 1996, were at a dosage of 0.3 lb copper sulfate per million gallons of water, down from the 1 lb per million gallons previously used. The May dosage increased the concentration of copper from 5.0 ug/l (background) to 5.2 ug/l.

The SFWD supply is 6 percent through the SVFP; the remainder is delivered direct from Hetch Hetchy Reservoir. When weighted by this proportion, copper sulfate dosed to Calaveras and San Antonio Reservoirs increases copper in the SFWD supply by an insignificant 0.012 ug/l.

Zinc Orthophosphate and Corrosion. The SCVWD doses its treated water supply with 0.4 mg/l zinc orthophosphate to inhibit corrosion in the distribution system. The dosage can be confirmed by comparing influent and effluent concentrations at the three treatment plants. See Table 5-20. This loading applies to 41 percent of total supply to the Sunnyvale WPCP service area (EOA 1996), 17 percent to the Palo Alto RWQCP service area and 41 percent to the SJ/SC WPCP service area (Copper and Selenium Steering Committee, January 1993). The remaining water supplies do not include zinc orthophosphate additive.

Corrosion of pipes, solder at pipe joints, faucets and fixtures add copper and lead to tap water. POTWs used 1990-1994 tap water sampling data to calculate copper concentrations due to corrosion of plumbing materials. Weighting first-flush and full-flush concentrations at 10 percent and 90 percent, respectively, the POTWs calculated the contribution from corrosion as 34 ug/l copper. Using the same ratio, and the City of Sunnyvale 1992 samples, the contribution of lead from corrosion is 0.4 ug/l.

Summary of Loading to Storm Drains From Tap Water. Table 5-21 summarizes the estimated loads that enter the storm drains and the contribution of each source that affects the potable water supply concentration. For example, the copper loading from the water supply, 714 lb/yr, is the addition of copper from corrosion, copper sulfate addition and raw (reservoir) water.

The largest source of copper in potable water is from the corrosion of plumbing materials. The copper loading from copper sulfate addition to reservoirs and the SBA is negligible. For lead,

source water is a larger contributor of lead than corrosion. Zinc orthophosphate addition accounts for almost all of the zinc in the potable water supply. Loadings for mercury, selenium and silver are based on mostly nondetectable analytical results, and are likely lower, or much lower, than the estimates shown.

5.7.4 Limitations

The estimate of "outdoor" water use may be low, since POTW influent flows include infiltration and inflow that is unrelated to water consumption. The water consumption values are purveyors' estimates that include estimated leakage in the distribution system. The estimates do not include independent water supply sources.

The estimated proportion of "outdoor" water use that reaches the storm drain system is an assumed value, and therefore uncertain. The percentage is the same as that used in a 1992 report (Woodward-Clyde 1992). In that report, the maximum possible contribution of zinc from potable supply was calculated by subtracting estimates of other known sources from the estimated total loading. This yielded around 50 percent of total outdoor use going to storm drains. This figure was revised to a still-conservative 10 percent.

The contribution from copper sulfate additions to the reservoirs and groundwater recharge facilities is limited by the small number of samples available. There was only one sample available for the SVFP background concentration and SVFP effluent during copper sulfate addition. No data are available regarding the loading that would result form the addition of copper sulfate to recharge facilities.

Approximately 36 data sets were used to calculate the zinc concentration attributable to zinc orthophosphate. There were no nondetectable values. The behavior of zinc as it travels through the potable water distribution system is unquantified (i.e. not all zinc may actually reach taps).

The report, *Copper and Selenium in Water Supply of the Santa Clara Valley* (Copper and Selenium Steering Committee, January 1994) contains a complete discussion of the methodology used to calculate the increase in copper concentration caused from corrosion of plumbing materials. Limitations included the number of water use surveys available for calculating the 10 percent/90 percent blend ratio, the number of samples that can be associated with plumbing types (copper, galvanized steel or both), and the adequacy of control over samples taken in the field by volunteers. To confirm the 10 percent/90 percent ratio for first flush and full-flush tap water samples, the study also calculated the corrosion contribution by subtracting the water supply concentration and other estimated domestic sources of copper from the average residential sanitary sewer copper concentrations. These calculations by difference were within 8 percent-20 percent of the 10 percent/90 percent blend ratio calculation. Investigators concluded that the comparison supported using the 10 percent/90 percent blend ratio methodology to calculate the corrosion contribution.

The same limitations in the methodology for calculating a copper concentration from corrosion apply to calculating a lead concentration from corrosion. In addition, only one data set of City of Sunnyvale tap water samples was used to represent the differing water supply blends in all three service areas.

For the purposes of the lead and copper rule, samples are taken from interior plumbing (e.g. the kitchen sink). Much water used outdoors (particularly for irrigating parks or commercial/industrial areas) is not affected by interior plumbing and may have lower lead and copper concentrations. Note, in particular, that concentrations at hydrants are substantially lower than at indoor taps.

5.7.5 Uncertainty and Methods to Improve Estimate

Because the calculation of loads used very conservative estimates of both flow and concentrations, the estimate of loading from this source is probably quite high. The actual loads are almost certainly not higher, and may be negligible compared to most other sources of metals. This is particularly true for metals other than lead and copper. ("At the tap" concentrations were available for these two metals).

The estimates of average concentration of metals in potable water entering storm drains could be improved by:

- Determining the proportion of "outdoor" use attributable to parks, commercial/industrial, and residential land uses. This could be estimated from water use records.
- Sampling at hose bibbs and sprinkler heads at locations representative of each of these uses, and analysis for all metals of concern at appropriate detection limits (i.e. to avoid non-detects).

There may not be any feasible way to improve the estimate of the proportion of potable water use that reaches storm drains.

5.8 MINING SOURCES

5.8.1 Background

The Guadalupe watershed has been identified as a significant mercury source to the Bay, owing to prior mining of mercury ore within the watershed. Most of the mining activities occurred within what was once known as the New Almaden Mining District and is now the present location of the Almaden Quicksilver County Park (Park). Mercury mining within the Park began in 1845 and occurred up to 1975, when the area was purchased by the County of Santa Clara for use as a recreational park. Almaden Quicksilver County Park occupies approximately 3,750 acres in the foothills of the Santa Cruz mountains, on Los Capitancillos Ridge. The ridge is

characterized by steep, rocky slopes. Seventy five percent of the total park area drains into the Guadalupe River via intermittent creeks and perennial streams. The remaining area drains into the Guadalupe and Almaden Reservoirs.

Inactive mercury mines in the New Almaden area include: Guadalupe, Senator, San Mateo, San Antonio, Enriquita, San Francisco, Providencia, American and New Almaden. The principal mercury ore in the area is cinnabar (mercury sulfide), which is situated within a host silica-carbonate rock. The cinnabar is processed by crushing the ore and reducing the ore to elemental mercury in retorts or furnaces. The burned rock, referred to as calcines, were typically dumped in piles near the processing areas or used as road base material. Generally, the calcines are sandy or silty gravel material. The calcine piles still remain at the site and vary in area, steepness, mercury concentration and particle size distribution. Erosion and runoff from calcine piles, waste rock piles (unprocessed rock due to low mercury concentrations) and road material cause mercury-laden sediment to be transported into nearby surface water bodies.

5.8.2 Methodology and Data Sources

The mercury load into the South San Francisco Bay (Bay) due to mining activities was assumed to originate from the inactive mercury mines in the Park. Loads into the Bay and reservoirs were estimated using surface water quality data collected during an environmental mercury assessment at the Park (Dames & Moore 1989). The load was calculated using the average mercury concentration estimated from the water quality data, drainage areas to each relevant surface water body, the annual average rainfall at the Park, and an estimated annual surface runoff coefficient.

General background information and surface water quality data were obtained from the following sources (see references for full citation):

- Dames & Moore 1989. Environmental Mercury Assessment, Phase 3, Almaden Quicksilver County Park for the County of Santa Clara.
- Dames & Moore 1989. Interim Report Soil and Stream Sampling Program Environmental Mercury Assessment, Phase III Almaden Quicksilver County Park for the County of Santa Clara.
- Camp Dresser & McKee 1994. Final Remedial Action Plan Environmental Mercury Assessment Phase V Almaden Quicksilver County Park.

Surface water samples were collected from creeks draining the mine areas within the Park (Dames & Moore 1989). Samples were collected during high flow conditions during the first runoff event of the season. The samples (including water and suspended sediment) were analyzed for total mercury. The analytical data used to calculate the average mercury runoff concentration are provided below. The method detection limit was used for mercury concentrations reported as not-detected (ND).

Sample Location	Mining/Processing Drainage Area	Date Sampled	Mercury Conc. [mg/l]	Detection Limit [mg/l]
Deep Gulch Creek	Mine Hill	3/25/89	0.001	0.001
Unnamed: to Jacques Gulch and Almaden Reservoir	Mine Hill	3/25/89	0.002	0.001
North Los Capitancillos Creek	Mine Hill	1/23/89	ND	0.001
Unnamed: northeast park boundary	Area unaffected by mining	3/25/89	ND	0.001
Alamitos Creek	Hacienda Furnace Yard	5/19/89	ND	0.001
Alamitos Creek	Hacienda Furnace Yard	5/19/89	ND	0.001
Unnamed spring at mouth of Day Tunnel	Day Tunnel	6/28/89	ND	0.001

The average annual runoff coefficient was estimated using the formula provided in the Hydrology and Hydraulics Criteria Summary Western Alameda County (Alameda County Public Works Agency 1989). The equation for calculating the modified runoff coefficient, C', is:

$$C' = C + C_s + C_i$$

where:

C = the basic runoff coefficient based on land use

= 0.2 for parks and undeveloped land

C_s = the slope adjustment factor

C_i = the rainfall intensity adjustment factor

C_s is calculated using the following equation:

$$C_s = \frac{(0.8 - C)(\ln(S - 1))\,S^{0.5}}{56}$$

where:

S = the average ground slope of the incremental drainage area in percent

The rainfall intensity adjustment factor is calculated using the following equation:

$$C_i = \{0.8 - (C + C_s)\} \left| 1 - \frac{1}{\left(\frac{1}{e^i}\right) + (\ln(i+1))} \right|$$

where:

i = the storm rainfall intensity (inches/hour)

= rainfall intensity factor (I_2) x mean annual rainfall [in]

(the 2 year 24 hour rainfall intensity factor was used)

The annual mercury load into the Guadalupe River, Guadalupe Reservoir and Almaden Reservoir was calculated using the following equation:

Load = Conc. x Area x Rainfall x Runoff x CF

where:

Load = Annual mercury load [lbs/yr]

Conc. = Mean mercury surface water concentration [μg/l]

Area = Drainage area [acres]

Rainfall = Mean annual rainfall at the Park [in.]

Runoff = Mean annual runoff coefficient, C'

CF = Unit conversion factor = $2.26 \times 10^{-4} \left[\frac{ft \bullet L \bullet lb}{in \bullet acre - ft \bullet \mu g}\right]$

5.8.3 Results

The input parameters for the load calculation are provided in Table 5-22. An average 1:1 slope (which corresponds to 100 percent) was assigned to the park area to represent the calcine piles, which varied in steepness, and the remaining park area slope that has been documented as having slopes of 0.5:1 to 0.25:1 (Camp Dresser & McKee 1994).

The estimated mercury load into the Bay from runoff into the Guadalupe River is 11 lbs/yr. Mercury loads into the Almaden and Guadalupe Reservoirs are estimated to be 2 lbs/yr and 1 lb/yr, respectively.

5.8.4 Limitations of Approach

Factors that may affect the above calculations are discussed below:

- The estimated total mercury load is based on limited water quality data (six samples, four of which were non-detect). The representativeness of these data is questionable due to the very low reported TSS concentrations (< 1.0 mg/L) compared to storm water values which generally range between about 50-300 mg/L. Another suite of analyses were performed on five of the six samples in which the water samples were filtered and the suspended sediment and supernatant analyzed separately. The mercury concentrations of the suspended sediment were within the expected range, as they correspond to soil and sediment concentrations reported in the Guadalupe River (USGS 1986, Woodward-Clyde 1992). However, the total mercury concentrations are biased low due to the extremely low TSS concentrations.

- No water quality data could be obtained for Hillsdale and Silver Creek Mines, which are located within the Coyote Watershed. Erosion from these mines would potentially be a source of mercury to the Bay.

- The annual runoff coefficient for the Park was calculated using an equation designed to calculate storm-specific runoff coefficients. In addition, a slope of 100 percent was considered representative of the entire Park, although the area varies significantly in steepness.

5.8.5 Uncertainty

Based on the above considerations, the estimated mercury sediment loads into reservoirs and the Bay are considered to have high uncertainty. The primary uncertainty is due to the questionable surface water quality data used to calculate the average mercury concentration for the loads estimate. These data do not appear to be representative of sediment yield from an inactive mining area that consists of several acres of tailing piles, some in close proximity to stream banks (sampling apparently occurred at locations closely downstream from where potential erosion from tailing piles and road runoff would occur). No other TSS and surface water mercury data are available for the Park. The Guadalupe watershed does have elevated mercury concentrations relative to the other watersheds within the study area. Erosion and runoff from the tailings piles, road base material and unprocessed rock are the likely source of mercury, however, due to lack of satisfactory data, the load can not be adequately quantified.

5.8.6 Suggestions for Future Work

In lieu of adequate surface water quality data from the Park, a more accurate estimate of the sediment yield could be estimated using the Universal Soil Loss Equation. This would require information on the slopes of the tailing piles and other areas in the Park as well as soil

characteristics and particle size distribution. An aqueous mercury concentration could then be calculated using Woodward-Clyde and USGS sediment data for the Guadalupe Watershed.

It is recommended that additional sampling be performed to obtain more representative TSS concentrations. Better data might be obtained by collecting samples from the bottom of the mining sub-catchment, such as a location on Alamitos Creek. Samples should be collected during several storm events, during high flow conditions. The samples should be analyzed for TSS and total and dissolved mercury, to distinguish aqueous and particulate mercury concentrations and to obtain representative TSS concentrations. In addition, the rainfall intensity for each storm event should be measured to extrapolate a more accurate annual runoff coefficient.

5.9 SUMMARY OF SOURCES TO THE BAY BY METAL

The following sections provide an assessment of the *pollutants of concern* (copper, nickel, mercury, selenium and silver) sources to the Bay. Where possible, sources are distinguished by point (POTW), nonpoint urban and other nonpoint sources, to consider the overall contribution of each source. Thereafter, urban nonpoint sources are evaluated separately to evaluate the significance of each urban metal source so that control measures might be prioritized.

The loads estimated in Section 5.0 were apportioned based on the loads estimates in Section 4.0 to consider the relative contribution of nonpoint and point sources to the total storm water load. The nonpoint loads were not apportioned based on the level of certainty associated with the estimate, as a quantitative uncertainty analysis was not performed for each source identification method (uncertainty was evaluated qualitatively by assigning high, medium and low levels of uncertainty to each load estimate). Therefore, a linear apportionment of loads was performed. The reader should refer to the individual source identification sections for the limitations affecting the estimated metal load from each source. However, load estimates that were derived using primarily non-detect data are noted in the footnotes to Tables 5-23 through 5-30, so the reader can use this information when evaluating the relative contributions from the various sources.

Load contributions were designated by point, urban nonpoint and other (natural erosion, mining, reservoir releases) nonpoint only when there was enough certainty associated with the load estimates to do so. For example, the contribution from urban and other nonpoint loads to the total nonpoint loads for silver and selenium could not be evaluated confidently, due to overall uncertainty associated with the load estimates for these metals.

5.9.1 Copper

Table 5-23 summarizes the copper sources to the Bay. Urban nonpoint sources appear to contribute the greatest portion of the load, estimated at about 53 percent of the total load,

followed by point sources estimated at about 28 percent of the total load, and other nonpoint sources (natural erosion, reservoir releases) estimated at about 19 percent of the total load. The greatest source of copper appears to be from brake pads, estimated at about 42 percent of the total load.

Table 5-24 apportions the urban nonpoint storm water load. Brake pads appear to be the most significant source, estimated at about 80 percent of the total urban nonpoint load. Water supply/corrosion and industrial activities each contribute about 7 percent of the total urban load. Other urban nonpoint source contributions appear to be relatively minimal (each source contributing up to a maximum of 1 percent of the total urban nonpoint load).

5.9.2 Nickel

Table 5-25 summarizes the nickel sources to the Bay. The greatest load contribution appears to be from other nonpoint sources, which contribute about 60 percent of the total load. Point sources contribute about 27 percent of the total load and urban nonpoint sources contribute about 13 percent of the total load. The largest single source contribution appears to be from natural erosion, which is due to the high background nickel concentration in Santa Clara soils.

Pilot sediment sampling study data from Calabazas Creek also indicates high upland nickel concentrations (SCVNPSCP 1996). Sediment data from two upland reaches and three urban reaches were studied to evaluate if nickel enrichment occurs in the urbanized portion of the watershed. These data indicate that enrichment does not occur and than upland erosional sources of nickel are more important than urban sources.

Table 5-26 summarizes the contribution of urban nonpoint sources of nickel to the Bay. The greatest contribution appears to be from industrial discharge and runoff, estimated at about 43 percent. Significant contributions are from construction erosion and tailpipe emissions, estimated at about 17 and 28 percent of the total urban load. Automotive sources contribute about 8 percent of the urban nickel load; primary automotive sources of nickel are coolant and motor oil.

Based on the loads estimate, it appears that the primary sources of nickel in storm water are unrelated to urban nonpoint sources, and therefore, control may be difficult, although pollutant trading is a potential alternative mechanism that could be utilized in this regard (see Section 6.0).

5.9.3 Mercury

Table 5-27 summarizes the mercury sources to the Bay. Point sources contribute a very minor portion of the load, estimated at about 3 percent of the total load. Other nonpoint sources contribute the greatest portion, estimated at about 58 percent of the total load, and urban nonpoint sources contribute an estimated 39 percent of the total load.

The relative mercury loads from mining erosion and reservoir releases warrant some explanation. The loads from reservoir releases (estimated at 39 pounds per year for a total of six reservoirs) are greater than the estimated mercury loads into the Almaden and Guadalupe reservoirs, estimated at about 2 and 1 pound per year, respectively from mining erosion. Both estimates have high uncertainty. The greater loads from reservoir releases are due to the large flow volume associated with the releases. Some of the sediment that enters the reservoir settles to the bottom and is not released during overflow. Moreover, mining erosion estimates are considered to be underestimated.

Table 5-28 summarizes the contribution of urban nonpoint sources of mercury to the Bay. The most significant source (79 percent of the load) of mercury appears to be tailpipe emissions due to the mercury present in diesel fuel. Contributions from industrial activities and water supply are estimated at about 8 and 10 percent, respectively, of the total urban nonpoint load. The contribution from construction erosion is relatively small, estimated at about 3 percent of the total load. This is due to the low background mercury soil/sediment concentration within the study area, with the exception of the New Almaden District, which is the location of former mining activity.

The estimated loads from mining, reservoir releases and industrial activities were based primarily on non-detect data, therefore loads are likely overestimated (except for mining, where the estimates are believed to be low). This should be considered when comparing the relative contribution of each source to the total storm water load.

5.9.4 Silver

Table 5-29 summarizes the load contribution from point and nonpoint sources. Based on the load estimates, point sources appear to contribute about 86 percent of the total load, compared to 14 percent contributed from nonpoint sources. The relative contributions (percentages) from specific urban and other nonpoint sources were not provided in the table and the pie chart due to the overall uncertainty associated with the load estimates from the various nonpoint sources. No background silver data were available for the study area, therefore, natural erosion and erosion from construction activity could not be estimated. Therefore, it is inaccurate to assume that all of the nonpoint sources have been accounted for in these estimates. Consequently, assigning a relative percent contribution from each nonpoint source would be misleading.

The estimated loads from point sources, and industrial activities were based primarily on non-detect data, therefore loads are high. This should be considered when comparing the relative contribution of each source to the total storm water load.

5.9.5 Selenium

Table 5-30 summarizes the load contribution from point and nonpoint sources. Based on the load estimates, point sources appear to contribute about 78 percent of the total load, compared to 22 percent contributed from nonpoint sources. The relative contributions from urban and other nonpoint sources were not provided due to the overall uncertainty associated with the load estimates from nonpoint sources.

The estimated loads from industrial activities and reservoir releases were based primarily on non-detect data, therefore loads are high. This should be considered when comparing the relative contribution of each source to the total storm water load.

5.10 SUMMARY OF LOADS TO THE BAY BY SOURCE

Table 5-31 summarizes percent loads to the bay by source and by these metals. As evidenced in the table, nonpoint sources contribute relatively smaller percentages of total loads of silver and selenium to the South Bay. Due to uncertainty associated with the data, it is difficult to estimate the percentage of the loads of these two metals contributed by urban nonpoint sources. Given the small contribution of loads of these metals by nonpoint sources, no specific controls are identified for these metals. It may be appropriate to discuss additional control measures within a watershed framework (see Section 6.9).

With respect to the three other *pollutants of concern*, urban nonpoint sources appear to contribute a significant percentage of total copper load to the bay, accounting for over half the estimated copper load. By contrast, urban nonpoint sources contribute less significant proportions of the total mercury and nickel loads to the bay.

5.11 RECOMMENDATIONS FOR IMPROVED QUANTIFICATION OF LOAD ESTIMATES

The Program will take advantage of opportunities to improve the quantification of sources of metals (especially copper, nickel and mercury) and loads to receiving waters. In particular, the focus will be on sources that appear to be major sources and for which the estimates have a high relative uncertainty. The primary emphasis of the Program will be on urban sources, but the Program will work actively with the Watershed Management Initiative and other initiatives (e.g., Brake pad Forum) to help improve the quantification of non-urban sources.

Table 5-32 shows all the nonpoint sources identified in Section 5 for copper, nickel, and mercury, the percentage of estimated total load associated with each source, qualitative and quantative measures of the relative uncertainty in each estimate, and an overall ranking based on a combination of the magnitude of the source and uncertainty in the estimate. We would recommend that the focus on improving quantification address those copper and mercury sources whose overall rank is 4 and above, and nickel sources whose overall rank is 3 and above.

As indicated in Table 5-32, the urban copper storm water sources that warrant improved quantification are brake pads, water supply, and industrial facility discharges. Suggestions for improved quantification of source and load estimates for copper follow:

Brake Pads:

- Include concentration data for new and replacement brake pads from manufacturers, so that estimates are more representative of brake pads used in Santa Clara County.
- Include the contribution of brake pad dust from drum, heavy duty vehicle and airplane brakes.
- Investigate transportation pathways to better quantify what portion of brake pad releases enter the Bay through the storm drain system.

Water Supply:

- Improve estimate of the amount of potable water used outdoors (Currently being addressed in part by Utility Performance Standard Work Group).
- Improve estimate of copper concentrations from potable water sources.
- When sampling, use sufficiently low detection limits to avoid biasing load estimate.

Industrial Discharges:

- Loads should be estimated for all categories of facilities that are required to monitor storm water for metals under the General Permit.
- Lower analytical detection limits should be used, to avoid the use of the detection limit in the load estimate for non-detect data.
- Work should be done with the facilities to better identify representative sampling points for storm water runoff.
- Loads should be calculated only after careful pooling of the data, to avoid skewing the load estimates because of a few high concentration measurements

The urban nickel storm water sources that may require improved quantification are industrial discharges and tailpipe emissions. Suggestions for improving load estimates from industrial discharge sources have been discussed above. The following descibes information gaps surrounding tailpipe emission estimates.

Tail Pipe Emissions

- Improve speciation and emission inventory data used to estimate vehicular exhaust metals emissions.

- Improve understanding of transport processes that may cause vehicular emissions to enter the storm drain system and ultimately discharge into tributary streams and the South Bay.

The urban storm water sources of mercury that have been ranked higher priority are tailpipe emissions and water supply, which have been addressed above. Mining is dentified as a high priority non-urban nonpoint source. Suggestions for improving the load estimate from this source are summarized below:

Mining

- An improved estimate of sediment yield could be obtained using the Universal Soil Loss Equation, which requires information including the slopes of the tailing piles and other metal-laden areas, soil characteristics and particle size distribution.

- Additional sampling could be performed at the bottom of the mining sub-catchment, to obtain more representative TSS concentrations. The samples should also be analyzed for total and dissolved mercury.

- The rainfall intensity of each storm event should be measured to obtain an improved annual runoff coefficient and annual load estimate.

For all of the *pollutants of concern* discussed above, natural erosion and reservoir spills contribute a significant portion to the total storm water load, however, these load estimates were obtained using limited background metal concentration data. Suggestions to improve the load estimate from these sources follow:

Natural Erosion and Reservoir Spills:

- Soil samples could be collected from the urban boundary within each watershed to obtain more representative background metal concentrations.

- Natural erosion sediment yield could be estimated using the Flaxman Equation, which requires information including precipitation, watershed slope, particle size distribution, soil clay content and storm event peak discharge rates. Ideally, the method would be modified to include gully and channel erosion.

- Consider sampling at appropriately low detection limits at spillways during reservoir releases. Samples should be analyzed for total and dissolved metals, in addition to TSS.

TABLE 5-1
ESTIMATED 1995 ANNUAL LOADS FOR WASTEWATER TREATMENT PLANTS

SAN JOSE/SANTA CLARA WATER POLLUTION CONTROL PLANT

		Arsenic		Cadmium		Chromium		Copper		Lead		Mercury*		Nickel		Selenium		Silver		Zinc	
	Flow Avg mgd	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.	Avg Conc µg/L	Total Mass lb/mo.
Jan	137	<1	35.5	<0.5	17.8	1.2	42.5	5.2	183	<1	46.8	<0.2	7.1	12	436.5	1.5	51.9	<1.0	35.5	55	1,961
Feb	125	<1	29.1	<0.5	14.6	0.9	28.9	4.5	132	<2	40.8	<0.2	5.8	13	371.8	0.9	26.5	<1.0	29.1	57	1,671
March	146	<1	37.8	<0.5	18.9	0.8	26	4.9	182	<1	37.8	<0.2	7.6	10	377.3	1	38.5	<1.0	37.8	57	2,151
April	127	<1	31.9	<0.5	15.9	<0.6	19.9	4.3	137	<1	31.9	<0.2	6.4	10	322.2	1.1	34.7	<1.0	31.9	54	1,748
May	123	<1	31.8	<0.5	15.9	0.6	19	4.2	136	<1	31.8	<0.2	6.4	12	406.6	0.6	18.9	<1.0	31.8	48	1,528
June	123	<1	30.9	<0.5	15.4	0.6	19.2	3.7	113	<1	30.9	<0.2	6.2	9	282	0.4	12.4	<1.0	30.9	43	1,314
July	121	<1	31.4	<0.5	15.7	0.9	32	3.5	110	<1	31.4	<0.2	6.3	10	301.1	0.7	22	<1.0	31.4	36	1,121
Aug	129	<1	33.5	<0.5	16.7	<1.1	36.9	4	134	<1	41	<0.2	6.7	10	347.6	0.6	20.1	<1.0	33.5	34	1,141
Sept	126	<1	31.5	<0.5	15.8	1.2	36.4	4	127	<1	31.5	<0.2	6.3	11	351.9	0.6	18.9	<1.0	31.5	38	1,188
Oct	124	<1	32.2	<0.5	16.1	0.6	20.4	3.9	130	<1	42.6	<0.2	6.4	9	281.4	0.5	16.1	<1.0	32.2	33	1,143
Nov	124	<1	31	<0.5	15.5	0.7	22.9	5.1	159	<2	49.8	<0.2	6.2	11	335.9	0.9	27.9	<1.0	31	52	1,610
Dec	128	<1	33	<0.5	16.5	0.7	24.9	6.3	202	1	33	<0.2	6.6	9	289.6	0.7	23.1	<1.0	33	33	1,096
Total	46,693		390		195		329		1,745		449		78		4,104		311		390		17,671

Note: Mass loadings were calculated by multiplying sample concentrations by the total flow for that time period. The mass loadings were not calculated using average flow and average concentration data.

* Low-detection - limit analyses in 1996 yielded a mean result of 0.002 µg/L (Dan Bruinsma, City of San Jose, personal communication 9/12/96).

TABLE 5-2
ESTIMATED 1995 ANNUAL LOADS FOR WASTEWATER TREATMENT PLANTS

CITY OF SUNNYVALE WATER POLLUTION CONTROL PLANT

	Flow Avg mgd	Arsenic Avg Conc µg/L	Arsenic Total Mass lb/mo.	Cadmium Avg Conc µg/L	Cadmium Total Mass lb/mo.	Chromium Avg Conc µg/L	Chromium Total Mass lb/mo.	Copper Avg Conc µg/L	Copper Total Mass lb/mo.	Lead Avg Conc µg/L	Lead Total Mass lb/mo.	Mercury* Avg Conc µg/L	Mercury* Total Mass lb/mo.	Nickel Avg Conc µg/L	Nickel Total Mass lb/mo.	Selenium Avg Conc µg/L	Selenium Total Mass lb/mo.	Silver Avg Conc µg/L	Silver Total Mass lb/mo.	Zinc Avg Conc µg/L	Zinc Total Mass lb/mo.
Jan	18.09	<1	4.7	<0.2	1.1	<5	23.4	6.2	28.8	<1	4.7	<0.2	0.9	4.8	22.1	<1	4.7	<0.2	1.2	<7	46.6
Feb	21.5	<1	5.0	<0.3	1.5	<5	25.1	4.9	28.2	<1	5.0	<0.2	1.0	2.8	16.7	<1	5.0	0.3	1.7	25	105.1
March	13.97	<1	3.6	<0.3	0.9	<5	18.1	5.1	18.1	<1	3.6	<0.2	0.7	3.5	12.7	<1	3.6	0.2	0.6	27	85.9
April	18.49	<1	4.6	<0.2	1.3	<5	23.1	5.2	28.9	<1	4.6	<0.2	0.9	<3	12.1	<1	4.6	<0.2	0.8	41	179.5
May	13.73	<1	3.6	<0.2	0.7	<5	17.8	4.3	15.1	<1	3.6	<0.2	0.7	2.8	10.5	<1	3.6	<0.2	0.9	23	96.6
June	10.86	<1	2.7	0.3	0.8	<5	13.6	3.9	10.8	<1	2.7	<0.2	0.5	4.8	11.6	<1	2.7	0.2	0.5	16	43.4
July	12.31	<1	3.2	<0.2	0.8	<5	15.9	3.7	11.9	<1	3.2	<0.2	0.6	2.7	9.3	<1	3.2	<0.1	0.3	19	64.9
Aug	16.44	<1	4.3	0.5	2.1	<5	21.3	2.5	10.8	<1	4.3	<0.2	0.9	3.2	14.0	<1	4.3	0.2	0.9	26	111.0
Sept	8.68	<1	2.2	<0.3	0.7	<5	10.9	3.7	7.6	<1	2.2	<0.2	0.4	3.5	7.3	<1	2.2	0.3	0.6	<7	25.0
Oct	13.29	<1	3.4	<0.2	0.7	<5	17.2	3.5	11.6	<1	3.4	<0.2	0.7	<2.6	9.4	<1	3.4	<0.2	0.5	20	59.5
Nov	12.29	<1	3.1	<0.2	0.6	<5	15.4	2.6	9.3	<1	3.1	<0.2	0.6	3.5	10.8	<1	3.1	<0.2	0.5	17	60.9
Dec	19.25	<1	5.0	<0.2	1.0	<5	24.9	4.8	21.9	<1	5.0	<0.2	1.0	<2	11.6	<1	5.0	0.3	1.3	22	110.3
Total	5,431		45		12		226		203		45		9		148		45		10		989

Note: Mass loadings were calculated by multiplying sample concentrations by the total flow for that time period. The mass loadings were not calculated using average flow and average concentration data.

* Low-detection-limit analyses in 1993 yielded a mean result of 0.006 µg/L. (City of Sunnyvale, Organics and Selected Metals Effluent Limits Analysis 9/1/93.)

TABLE 5-3
ESTIMATED 1995 ANNUAL LOADS FOR WASTEWATER TREATMENT PLANTS

PALO ALTO REGIONAL WATER QUALITY CONTROL PLANT

	Flow Avg mgd	Arsenic Avg Conc µg/L	Arsenic Total Mass lb/mo.	Cadmium Avg Conc µg/L	Cadmium Total Mass lb/mo.	Chromium Avg Conc µg/L	Chromium Total Mass lb/mo.	Copper Avg Conc µg/L	Copper Total Mass lb/mo.	Lead Avg Conc µg/L	Lead Total Mass lb/mo.	Mercury* Avg Conc µg/L	Mercury* Total Mass lb/mo.	Nickel Avg Conc µg/L	Nickel Total Mass lb/mo.	Selenium Avg Conc µg/L	Selenium Total Mass lb/mo.	Silver Avg Conc µg/L	Silver Total Mass lb/mo.	Zinc Avg Conc µg/L	Zinc Total Mass lb/mo.
Jan	29.1	5	37.6	<0.2	1.5	<1.0	7.5	7.8	65.5	<1.0	7.5	<0.1	0.8	4.5	38.4	2.7	20.3	<0.2	1.7	56	470
Feb	26	1.6	9.7	<0.2	1.2	<1.0	6.1	9	54.6	<1.0	6.1	<0.1	0.6	3.9	23.6	3	18.2	<0.2	1.2	57	347
March	32.6	1.2	10.1	<0.2	1.7	<1.0	8.4	6.5	50.7	1	8.4	<0.1	0.8	3.85	29.8	1.4	11.8	<0.2	1.6	48	371
April	26.9	1	6.7	<0.2	1.3	<1.0	6.7	6.5	41	<1.0	6.7	<0.1	0.7	2.3	14.4	3	20.2	<0.2	1.2	47	296
May	26	1.3	8.7	<0.2	1.3	<1.0	6.7	5.25	31.7	<1.0	6.7	<0.1	0.7	3.2	19.4	2	13.5	<0.2	1.2	54	326
June	25	1.1	6.9	<0.2	1.3	<1.0	6.3	28	40.8	<1.0	6.3	<0.1	0.6	3.825	22.8	2	12.5	<0.2	1.5	55	405
July	22.8	1.2	7.1	<0.2	1.2	<1.0	5.9	8	43.2	<1.0	5.9	<0.1	0.6	3.75	20.3	1.9	11.2	<0.2	1.2	70	377
Aug	23.8	1.2	7.4	<0.2	1.2	<1.0	6.2	7	48.1	<1.0	6.2	<0.1	0.6	3.78	25.9	1.6	9.9	<0.2	1.5	5	389
Sept	23.6	<1.0	5.9	<0.2	1.2	<1.0	5.9	7.25	40.1	<1.0	5.9	<0.1	0.6	3.4	18.8	<0.4	2.4	<0.2	1.2	55	303
Oct	24.6	<1.0	6.4	<0.2	1.3	<1.0	6.4	5.4	39	<1.0	6.4	<0.1	0.6	3.04	21.9	0.9	5.7	<0.2	1.5	53	385
Nov	25.5	<1.0	6.4	<0.2	1.3	<1.0	6.4	4.5	26.8	<1.0	6.4	0.2	1	3.925	23.5	0.3	1.9	<0.2	1.2	47	281
Dec	25.8	<1.0	6.7	<0.2	1.3	<1.0	6.7	5.25	31.9	<1.0	6.7	0.2	1.2	2.4	14.4	0.4	2.7	0.25	1.5	47	283
Total	9485		120		16		79		513		79		9		278		130		16		4,233

Note: Mass loadings were calculated by multiplying sample concentrations by the total flow for that time period. The mass loadings were not calculated using average flow and average concentration data.
* Low-detection-limit analyses in 1993 yielded a mean result of 0.12 µg/L (Ms. Kelly Moran, City of Palo Alto, personal communication 8/16/96).

TABLE 5-4
1995 POTW MASS LOADINGS

	Avg Flow mgd	Arsenic lb/yr	Cadmium lb/yr	Chromium lb/yr	Copper lb/yr	Lead lb/yr	Mercury* lb/yr	Nickel lb/yr	Selenium lb/yr	Silver lb/yr	Zinc lb/yr
City of Sunnyvale											
Dry Season	13	19	6	97	68	19	4	62	19	4	400
Wet Season	17	26	6	130	135	26	5	86	26	6	588
Total	15	45	12	226	203	45	9	148	45	10	989
Palo Alto RWQCB											
Dry Season	24	42	8	37	243	37	4	129	55	8	2,185
Wet Season	28	77	8	42	271	42	5	144	75	8	2,048
Total	26	120	16	79	513	79	9	278	130	16	4,233
San Jose/Santa Clara WPCP											
Dry Season	124	191	96	164	750	209	38	1,971	108	191	7,435
Wet Season	131	198	99	165	995	240	40	2,133	203	198	10,237
Total	128	390	195	329	1,745	449	78	4,104	311	390	17,671
All Three POTWs											
Dry Season	161	253	109	298	1,061	266	46	2,162	183	203	10,020
Wet Season	176	301	114	337	1,401	308	50	2,363	304	213	12,873
Total	169	555	223	634	2,461	574	96	4,530	486	416	22,892

Note: Estimates for cadmium, chromium, lead, mercury, and silver used detection limit as the concentration and therefore may be quite uncertain and should be viewed as an upper bound.

* Based on mean low-detection-limit data, annual loadings would be as follows:

Sunnyvale	0.27 lb
Palo Alto	0.95 lb
San Jose/Santa Clara	1.03 lbs
	2.25 lbs

TABLE 5-5
ANNUAL LOADS ESTIMATES
INDUSTRIAL SOURCES

	Electroplaters	Metal Finishers	Semi Conductors	Other	Total
Impervious Area (acres)	399	856	456	140	
Copper					
No. Data Points	206	160	40	74	
%ND	31	28	38	16	
Average Cu (µg/l)	383	119	125	124	
Adjusted Cu (µg/l)	333	69	75	74	
Cu Load (lbs/yr)	390	173	100	30	**693**
Nickel					
No. Data Points	177	168	31	33	
%ND	46	64	68	48	
Average Ni (µg/l)	330	98	60	44	
Adjusted Ni (µg/l)	289	57	19	3	
Ni Load (lbs/yr)	339	143	26	1	**509**
Silver					
No. Data Points	71	107	16	22	
%ND	93	90	100	55	
Average Ag (µg/l)	69	29	27	30	
Ag Load (lbs/yr)	80	72	36	12	**201**
Selenium					
No. Data Points	10	40	14	15	
%ND	100	100	93	100	
Average Se (µg/l)	5	45	4	6	
Se Load (lbs/yr)	6	113	6	3	**127**
Mercury					
No. Data Points	10	56	16	15	
%ND	90	66	94	27	
Average Hg (µg/l)	0	1	1	1	
Hg Load (lbs/yr)	0.3	2	1	0.4	**3**
Zinc					
No. Data Points	124	162	34	28	
%ND	4	9	0	4	
Average Zn (µg/l)	1020	763	635	5522	
Adjusted Zn (µg/l)	769	512	384	5271	
Zn Load (lbs/yr)	901	1289	513	2163	**4866**
Lead					
No. Data Points	174	152	65	75	
%ND	48	36	46	4	
Average Pb (µg/l)	97	68	43	155	
Adjusted Pb (µg/l)	37	7	0	94	
Pb Load (lbs/yr)	43	18	0	39	**100**
Cadmium					
No. Data Points	61	86	23	14	
%ND	82	60	96	14	
Average Cd (µg/l)	42	13	13	14	
Adjusted Cd (µg/l)	40	11	11	12	
Cd Load (lbs/yr)	47	28	15	5	**95**
Chromium					
No. Data Points	115	145	57	23	
%ND	77	60	67	43	
Average Cr (µg/l)	74	30	29	24	
Adjusted Cr (µg/l)	53	9	8	3	
Cr Load (lbs/yr)	62	23	11	1	**98**

Note: Concentrations were adjusted by subtracting the average residential concentration (from SCVNPS Loads Assessment Report, Woodward-Clyde, 1991) from the industrial concentrations to account for atmospheric deposition and other non-industrial sources.

TABLE 5-6
MEAN CONCENTRATIONS OF METALS IN RUNOFF FROM RESIDENTIAL LAND USE MONITORING STATIONS

Copper µg/l	Nickel µg/l	Selenium µg/l	Silver µg/l	Mercury µg/l	Cadmium µg/l	Chromium µg/l	Lead µg/l	Zinc µg/l
50.5	40	-	-	-	1.7	21.1	60.8	251

Source: Woodward-Clyde Consultants. 1991. Santa Clara Valley Nonpoint Source Study Volume I: Loads Assessment Report. Submitted to the Santa Clara Valley Water District.

TABLE 5-7
SANTA CLARA COUNTY FLOOD ZONE DISTRIBUTIONS[1]

Flood Zone[2]	Incorporated Cities	Total Area [acres]	Landscape Maintenance % of Total Area	*Commercial Agricultural Products* Agricultural Area [acres]	*Commercial Agricultural Products* % of County-Wide Agricultural Area
North Central	Cupertino, Saratoga, Monte Sereno, Sunnyvale, Santa Clara, San Jose, Campbell, Los Gatos	35,947	7	852	3
Central	Los Gatos, Campbell, San Jose, Santa Clara, Monte Sereno	67,136	13	2,125	7
East	Milpitas, San Jose	156,508	31	6,115	21
North West	Palo Alto, Los Altos Hills, Los Altos, Mountain View, Sunnyvale, Cupertino	38,098	8	362	1
South	Morgan Hill, Gilroy, San Jose	203,212	41	19,004	67
Total		***500,901***	100	***28,459***	100
Total Area Draining to South Bay (Total-South Zone)		***297,687***	*59*	*9,455*	*33*

Note:
[1] Source: Santa Clara Valley Water District Benefit Assessment Database. 1996.
Agriculture includes: orchard, intensive field crops, crops for livestock consumption and flower growers. Landscape maintenance includes golf courses, public and private gardens, etc.
[2] Flood zone areas also include unincorporated land.

TABLE 5-8
ANNUAL LOAD ESTIMATES
COMMERCIAL PESTICIDE AND FERTILIZER APPLICATION

Source	Estimated Mass of Active Ingredient (as $CuSO_4$) Applied in Santa Clara County[1] [lbs/yr]	Estimated Mass Copper Applied in Santa Clara County [lbs/yr]	Estimated Mass of Applied Copper in Study Area[2] [lbs/yr]	Estimated Copper Load[3] [lbs/yr]
Commercial Agricultural Products	4,640	1,847	609	30.5
Landscape Maintenance	3,673	1,463	863	43.2
Total	8,313	3,310	1,473	74

Note:
[1] Source: South Bay Copper Reduction Dialogue. Submitted to SCVNPS Pollution Control Program. 1994.
[2] Area draining to South Bay estimated using Santa Clara Valley Water District Benefit Assessment Database. 1996.
[3] Assumed 5 percent runoff of total applied copper mass.

TABLE 5-9
SUMMARY OF RWQCB CONSTRUCTION NOI DATABASE INFORMATION
CONSTRUCTION ACTIVITY IN SANTA CLARA VALLEY

Year of Activity Termination	No. of Sites Ending Construction within Year	Estimated Area Under Construction [acres/yr]
1992	5	86
1993	37	428
1994	33	498
1995	35	413
1996	30	367
1997	15	221
1998	6	247
Average Area per Year Under Construction [acres] [1]		*323*

Notes:
Source: RWQCB Construction NOI Database. 1996.
[1] Average annual area under construction based on estimates for period 1992-1998.

TABLE 5-10
ANNUAL LOAD ESTIMATES
NATURAL AND CONSTRUCTION SITE EROSION

Total Erosion Load[(1)] [lbs/yr]

Cu	Ni	Se	Hg	Pb	Cd	Zn
2,281	4,828	12	4	702	3	5,468

Load from Construction Site Erosion[(2)] [lbs/yr]

Cu	Ni	Se	Hg	Pb	Cd	Zn
93	198	0.5	0.2	29	0.1	225

Load Primarily from Natural Erosion (Total TSS Load- Construction Load) [lbs/yr]

Cu	Ni	Se	Hg	Pb	Cd	Zn
2,188	4,630	12	4	673	3	5,243

Note:

(1) The total erosion load was estimated using the total TSS load of 59,128,130 lbs/yr as calculated in Section 4. Average sediment concentrations were obtained from SCVWD dry weight data for upland station at Calabazas Creek (SCVWD 1994) (concentrations are in mg/kg): Cu=38.57, M=81.64, Se=0.20, Hg=0.06, Pb=11.88, Cd=0.05, Zn=92.46

(2) The load was estimated assuming a sediment yield of 2,421,923 lbs/yr. The total sediment yield was calculated assuming an average sediment yield of 7,500 lbs per acre.

TABLE 5-11
FLOW DATA FROM RESERVOIR SPILL RELEASES

Station	Location	Drainage Area (acres)	Year	Spill Release Flows (acre-feet)
R1	Stevens Creek Reservoir	10,924	1986	8,246.67
Average Flow				**8,246.67**
R2	Lexington Reservoir	23,859	1978	7,985.92
			1980	3,282.57
			1982	17,119.56
			1983	14,145.63
			1986	2,997.57
Average Flow				**9,106.25**
R3	Guadalupe Reservoir	3,808	1978	392.22
			1980	4.12
			1982	1,197.23
			1983	275.22
			1986	533.03
Average Flow				**480.36**
R4	Almaden Reservoir	7,667	1978	12.26
			1980	21.20
			1982	48.83
			1983	372.36
			1986	55.67
Average Flow				**102.06**
R5	Calero Reservoir	4,621	1982	1,791.52
			1983	464.25
Average Flow				**1,127.89**
R6	Anderson Reservoir	124,787	1980	26.58
			1982	44,830.23
			1983	113,190.29
Average Flow				**52,682.37**

Notes:
Reservoir flow data provided by Santa Clara Valley Water District for 1976-1990.

TABLE 5-12
RESERVOIR RELEASE CONCENTRATION DATA AND MASS LOADING

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	
	Conc.	Load	Conc.	Load	Conc.	Load	Conc.	Load	Conc.	Load	Conc.	Load
R1 Below Stevens Creek Reservoir	3	67	< 0.2	4	6	134	6	134	2	45	< 0.2	4
R2 Below Lexington Reservoir	2	49	< 0.2	5	3	74	7	173	2	49	< 0.2	5
R3 Below Guadalupe Reservoir	2	3	< 0.2	0.3	3	4	5	7	2	3	< 0.2	0.3
R4 Below Almaden Reservoir	7	2	< 0.2	0.1	190	53	7	2	2	1	< 0.2	0.1
R5 Below Calero Reservoir	4	12	< 0.2	1	4	12	4	12	< 1	3	< 0.2	1
R6 Below Anderson Reservoir	1	143	0.7	100	5	716	7	1,002	2	286	< 0.2	29
Total Load (lbs/yr)		277		111		993		1,331		387		39

	Nickel		Selenium		Silver		Zinc	
	Conc.	Load	Conc.	Load	Conc.	Load	Conc.	Load
R1 Below Stevens Creek Reservoir	5	112	< 0.5	11	0.4	9	9	202
R2 Below Lexington Reservoir	3	74	< 0.5	12	1	25	5	124
R3 Below Guadalupe Reservoir	8	10	< 0.5	1	0.2	0.3	7	9
R4 Below Almaden Reservoir	27	7	< 0.5	0.1	< 0.2	0.1	10	3
R5 Below Calero Reservoir	4	12	< 0.5	2	0.3	1	1	3
R6 Below Anderson Reservoir	3	429	< 0.5	72	0.8	115	16	2,291
Total Load (lbs/yr)		646		97		149		2,631

[1]. Conc= Concentration, obtained from Concentrations from 1988 sampling event during reservoir releases.

TABLE 5-13
ANNUAL EMISSION ESTIMATES
INDUSTRIAL STACK AND TAILPIPE EMISSIONS

Point Sources [1] (lb/yr)			Mobile Sources (CARB) [4] (lb/yr)		Mobile Sources (Speciation) [5] (lb/yr)	
Pollutant	Santa Clara Co.	Total Bay Area	Unleaded Fuel	Diesel fuel	Unleaded Fuel	Diesel fuel
Particulate Matter (exhaust)	--	--	--	--	270,100	1,379,700
Chromium	1.14 [2]	19 [2]	36.3	60.5	27	91
Nickel	20.7	3,400	572.1	--	19	39
Copper	0	370	--	--	49	67
Zinc (exhaust) [3]	0	5,200	--	--	632	111
Cadmium	10.07	93	--	--	--	--
Silver	0	0	--	--	0	51
Mercury	0	380	--	--	5	27
Lead	69	780	--	--	810	737
Selenium	0	510	--	--	5	53

Note:

(1) Source: Bay Area Air Quality Management District Toxic Air Contaminant Reduction Plan Annual Report 1994, Volume II

(2) Hexavalent Chromium

(3) "Exhaust" applies to mobile source emissions only. For the first two columns, this is simply zinc emissions from point sources.

(4) Source: CARB Emissions Inventory Reports for chomium and nickel, plus Santa Clara County vehicle miles traveled from CARB 1994 inventor

(5) Source: BURDEN7F emissions inventory for 1994 and EPA Air Emissions Speciation Manual (using composite profiles). EPA speciation data have not been updated to account for a lead decrease subsequent to the 1992 lead phase-out in fuel.

-- Not Estimated

TABLE 5-14
ANNUAL TAILPIPE EMISSION ESTIMATES
BY VEHICLE AND FUEL TYPE

	Emissions Derived from CARB Inventory Reports (lbs/yr)			Emissions in Santa Clara County from BURDEN7F (lbs/yr)			Exhaust Emissions using BURDEN7F and EPA Speciation Profiles (lbs/yr)								Tire Wear Emissions using BURDEN7F and EPA Speciation Profiles (lbs/yr)
	Santa Clara County Annual VMT (thousands)	Cr	Ni	Particulate Matter (Exhaust)	Particulate Matter (Tire Wear)	Pb	Cr	Ni	Cu	Zn	Ag	Hg	Pb	Se	Zn
Light Duty Diesel Auto	83,220	7.63	N/A	80,300	100	No lead in BURDEN7F report for 1994 year (values are zero)	1.6	0.8	2.4	36.9	0	0.8	27.3	1.6	1.0
Light Duty Diesel Truck	20,075	2.00	N/A	21,900	20		0.4	0.2	0.7	10.1	0	0.2	7.4	0.4	0.2
Heavy Duty Diesel Truck	332,150	50.89	N/A	1,168,000	1,760		81.8	35.0	58.4	58.4	46.7	23.4	642.4	46.7	17.9
Urban Bus Diesel	19,345	N/A	N/A	109,500	80		7.7	3.3	5.5	5.5	4.4	2.2	60.2	4.4	0.8
Diesel Total:	454,790	60.52	0	1,379,700	1,960		91.5	39.3	66.9	110.9	51.1	26.6	737.4	53.1	20.0
Light Duty Gas Auto (non-cat)	279,955	1.05	15.43	21,900	340		2.2	1.5	3.9	51.2	0	0.4	65.7	0.4	3.5
Light Duty Gas Auto (catalytic)	7,965,395	20.55	439.01	175,200	9,520		17.5	12.3	31.5	410.0	0	3.5	525.6	3.5	96.9
Light Duty Gas Truck (non-cat)	30,295	9.15	1.67	0	40		0	0	0	0	0	0	0	0.0	0.4
Light Duty Gas Truck (catalytic)	1,372,765	3.54	75.66	29,200	1,660		2.9	2.0	5.3	68.3	0	0.6	87.6	0.6	16.9
Med. Duty Gas Truck (non-cat)	20,805	0.08	1.15	0	20		0	0	0	0	0	0	0	0.0	0.2
Med. Duty Gas Truck (catalytic)	483,990	1.25	26.67	7,300	580		0.7	0.5	1.3	17.1	0	0.1	21.9	0.1	5.9
Heavy Duty Gas Truck (non-cat)	83,220	0.31	4.59	14,600	160		1.5	1.0	2.6	34.2	0	0.3	43.8	0.3	1.6
Heavy Duty Gas Truck (catalytic)	143,080	0.37	7.89	21,900	280		2.2	1.5	3.9	51.2	0	0.4	65.7	0.4	2.9
Gas Total:	10,379,505	36.29	572.06	270,100	12,600		27.0	18.9	48.6	632.0	0	5.4	810.3	5.4	128.3

N/A = Not Available
VMT = Vehicle Miles Traveled

Brake Pads

General Approach: storm water loads were estimated using a Monte-Carlo simulation based on brake pad metal concentration, mass and wear rate, average miles between brake pad replacement and the fraction of the total load that enters storm water.

Methodology	Data Sources	Model Input Parameters
Metal concentrations in 20 selected brake pads were determined through analytical testing.	Brake pad metal concentrations determined by EPA Method 6010.	Data from 17 out of 20 brake pads were used. The concentration of each metal was assumed to follow a log-normal distribution. (Refer to report cited below for specific concentrations.)
The number of brake pads was assumed to be 4 x the number of autos registered in Santa Clara County.	Number of registered autos in Santa Clara County provided by DMV (1992).	1,130,000
	Brake pad mass determined through analytical testing.	mean = 0.129 kg
Annual miles driven was estimated using CA system state highway miles driven in Santa Clara County, divided by the number of registered cars in the County, multiplied by 2 (because the ratio of non-highway miles to highway miles driven was assumed to be 1 to 1).	California Department of Transportation, 1992; CalTrans, 1991.	normal distribution (mean = 15,000)
Assume number of miles driven until brake pad replacement.	Personal communication, Garrett Van Camp, Ford; Steve Grafflin, Chrysler; Rick Johnson, Mercedes-Benz.	normal distribution (mean = 40,000 miles)
Estimate percent of total load that enters storm water.	Axtell and Zell, 1977; Kobriger and Geinopolos, 1984.	normal distribution (mean = 55%)

Note: Methodology is discussed in detail in: Woodward-Clyde Consultants. 1994. Contribution of Heavy Metals to Storm Water from Automotive Disc Brake Pad Wear. submitted to Santa Clara Valley Nonpoint Pollution Control Program. October 12.

TABLE 5-15
APPROACH FOR ESTIMATING STORM WATER LOADS FROM AUTOMOTIVE SOURCES

Tires

General Approach: Annual pollutant loads resulting from tire wear were estimated by multiplying the mass of tire lost per car by the average tire metal concentration.

Methodology	Data Sources	Relevant Numbers
Tire wear was assumed to be 1 cm (0.394 in) per 40,000 miles driven.	Goodyear Tire Shop, 1992	
The volume of tire worn in 40,000 miles calculated using standard tire dimensions	Tire dimensions provided by Christensen and Guinn, 1979.	average tire diameter = 25.5 in. average tire width = 6 in. average tire density = 1.07 g/cm^3 (17.53 g/in^3) Volume = 25.5 in x 6 in x 0.394 in = 60.2 in^3/40,000 mi Weight of tire worn per 40,000 miles = volume/density = 1057 g/ 40,000 miles
Assume average tire concentration.	Cadmium and zinc concentrations provided by Radian Corporation, U.S. Environmental Protection Agency. 1990 Air Emissions Species Manual, Volume 2: Particulate Matter Species Profiles. Second Edition., EPA-450/2-90-001b. January.	Cadmium = 0.008 % of weight Zinc = 1.018 % of weight
Estimate total mass of worn tire based on number of annual miles driven in Santa Clara County.	DMV, 1992. MVMA Motor Vehicle Facts and Figures, 1991. State of California Air Resources Board, 1991.	Number of automobiles in Santa Clara Valley = 1,130,000 Average U.S. miles per year = 10,382 (MVMA) Estimates of miles driven in Santa Clara County per automobile = 1.257 x 10^{10} miles/year (Air Resources Board).

Note: Methodology is discussed in detail in: Woodward-Clyde Consultants. 1992. Source Identification and Control Report. submitted to Santa Clara Valley Nonpoint Source Pollution Control Program. December 1.

Coolant Leaks and Illegal Dumping

General Approach: The storm water load resulting from coolant leaks was estimated by multiplying an estimated coolant mass by the average coolant metal concentration. The load due to illegal dumping was estimated by assuming that a percentage of the total coolant changes enters storm water.

Methodology	Data Sources	Relevant Numbers
Leaks		
Assume percentage of cars with coolant leaks.	Silverman, G.S., M.K. Stenstrom and S. Fam. Association of Bay Area Governments. 1985. Evaluation of Hydrocarbons in Runoff to San Francisco Bay. September.	1.2% x total cars (1,130,000) = 13,560 cars with leaks
Assume a leak volume is equivalent to 1 quart per week. Use this volume to calculate total coolant mass.	Professional judgment.	coolant density = 1000 kg/m^3 13560 qt/wk * 52 = 705,120 qt/yr = 667 m^3/yr 667 m^3/yr * 1000 kg/m^3 = 667,000 kg/yr
Assume average coolant metal concentration.	Shaheen, David G., U.S. Environmental Protection Agency. Office of Research and Development. 1975. Contributions of Urban Roadway Usage to Water Pollution. EPA-600/2-75-004. March.	Lead = 6 μg/g Copper = 76 μg/g Nickel = 16 μg/g Zinc = 14 μg/g
Illegal Dumping		
Assume number of miles driven per coolant change.	Honda, 1995.	coolant change every 30,000 miles
Estimate changes per year.	DMV, 1992. Motor Vehicle Facts and Figures, 1991.	miles driven in Santa Clara/miles driven per change = 1.2 x 10^{10} mi/30,000 mi = 400,000 changes per year.

Note: Methodology is discussed in detail in: Woodward-Clyde Consultants. 1992. Source Identification and Control Report. submitted to Santa Clara Valley Nonpoint Source Pollution Control Program. December 1.

TABLE 5-15
APPROACH FOR ESTIMATING STORM WATER LOADS FROM AUTOMOTIVE SOURCES
(Page 4 of 6)

Methodology	Data Sources	Relevant Numbers
Illegal Dumping continued		
Assume gallons disposed per change.	Chan, Ken (Antifreeze Environmental Services.) 1992. Telephone conservation with Louis J. Armstrong.	3.5 gallons per coolant change.
Assume coolant disposal pathway.	Funderburk, Jim (First Brands). 1992. Telephone conservation with Louis J. Armstrong.	400,000 coolant changes per year; 50 percent of the coolant changes done by individuals themselves; of that, 50 percent dispose waste coolant improperly; 75 percent of the improperly disposed coolant enters the storm water system.
	Professional judgment.	

Note: Methodology is discussed in detail in: Woodward-Clyde Consultants. 1992. Source Identification and Control Report. submitted to Santa Clara Valley Nonpoint Source Pollution Control Program. December 1.

TABLE 5-15
APPROACH FOR ESTIMATING STORM WATER LOADS FROM AUTOMOTIVE SOURCES
(Page 5 of 6)

Motor Oil Leaks and Illegal Dumping

General Approach: The storm water load resulting from motor oil leaks was estimated by multiplying an estimated oil mass by the average motor oil metal concentration. The load due to illegal dumping was estimated assuming that a percentage of the total motor oil changes enters storm water.

Methodology	Data Sources	Relevant Numbers
Leaks		
Assume number of cars with major oil leaks.	Silverman, G.S., M.K. Stenstrom and S. Fam. Association of Bay Area Governments. 1985. Evaluation of Hydrocarbons in Runoff to San Francisco Bay. September.	0.01% x total cars (1,130,000) = 113 leaks
Assume a leak volume is equivalent to 1.6 quarts per week. Use this volume to calculate total mass of leaked oil.	Professional judgment.	motor oil density = 850 kg/m^3
		181 qt/wk x 52 = 9402 qt/yr = 8.9 m^3/yr 8.9 m^3/yr x 850 kg/m^3 = 7565 kg/yr
Assume average motor oil metal concentration.	Shaheen, David G., U.S. Environmental Protection Agency. Office of Research and Development. 1975. Contributions of Urban Roadway Usage to Water Pollution. EPA-600/2-75-004. March.	Lead = 9 μg/g Copper = 3 μg/g Nickel = 17 μg/g Zinc = 1060 μg/g
Illegal Dumping		
Assume number of miles per motor oil change.	Professional judgment.	motor oil change every 5,000 miles = 2 changes per year.
Estimate total changes per year.		total number of cars x 2 changes per year = 2,260,000

Note: Methodology is discussed in detail in: Woodward-Clyde Consultants. 1992. Source Identification and Control Report. submitted to Santa Clara Valley Nonpoint Source Pollution Control Program. December 1.

TABLE 5-15
APPROACH FOR ESTIMATING STORM WATER LOADS FROM AUTOMOTIVE SOURCES
(Page 6 of 6)

Methodology	Data Sources	Relevant Numbers
Motor Oil Illegal Dumping continued		
Estimate professional changes per year.	Phone survey of 20 professional oil changers in Santa Clara Valley.	82 oil changes per week
Estimate number of professional oil changers in Santa Clara Valley.	Approximated from, city HazMat lists and Pacific Bell Yellow Pages.	300
Estimate a disposal pathway.	Department of Energy Survey, 1981.	2,260,000 oil changes per year; 50 percent of oil changes done by individuals themselves; 61 percent of these dispose of used motor oil improperly; 50 percent of the improperly disposed used motor oil enters the storm water system.
	Professional judgment.	

Note: Methodology is discussed in detail in: Woodward-Clyde Consultants. 1992. Source Identification and Control Report. submitted to Santa Clara Valley Nonpoint Source Pollution Control Program. December 1.

TABLE 5-16
ANNUAL LOAD ESTIMATES
AUTOMOTIVE SOURCES

Source[1]	*Load Estimate [lb/yr]*				
	Copper	Nickel	Lead	Zinc	Cadmium
Brake Pads[2]	7,700		439	3,120	
Tires				28,000	230
Coolant Leaks	112	24	9	21	
Coolant Illegal Dumping	166	35	13	31	
Motor Oil Leaks				18	
Motor Oil Illegal Dumping	7	42	22	2,600	
Total	8,000	101	483	33,790	230

Notes:

[1] Source: Woodward-Clyde 1992. Source Identification and Control Report. submitted to Santa Clara Valley Nonpoint Source Pollution Control Program. December 1.

[2] Woodward-Clyde 1994. Contribution of Heavy Metals to Storm Water from Automotive Disc Brake Pad Wear. submitted to Santa Clara Valley Nonpoint Pollution Control Program. October 12.

TABLE 5-17
POTABLE WATER TOTAL AND "OUTDOOR" USE

POTW	Avg Water Usage in Service Area (MGY)	Influent Flow to POTW (MGY)	Difference ("Outdoor" Use) (MGY)
SJ/SC WPCP	66,086 [1]	46,693	19,393
Sunnyvale WPCP	6,285 [1]	5,431	854
Palo Alto RWQCP	10,976 [2]	9,485	1,491
Total			21,738

Note:

[1] Based on 1995 water consumption numbers from Cities.

[2] Based on City of Sunnyvale 1995 water consumption numbers adjusted by ratio of POTW flows.

TABLE 5-18
CITY OF SUNNYVALE WATER SUPPLY RESULTS

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury		Nickel		Selenium		Silver		Zinc	
	(µg/L)	% ND	(µg/L)	% ND	(µg/L)	% ND	(µg/L)	% ND	(µg/L)	% ND	(µg/L)	% ND	(µg/L)	% ND	(µg/L)	% ND	(µg/L)	% ND	(µg/L)	% ND
Groundwater	0.57	90%	0.28	62%	2.28	10%	0.43	63%	0.18	100%	0.17	98%	0.79	77%	0.67	85%	0.10	87%	14	42%
SFWD Hetch Hetchy	0.61	92%	0.14	75%	0.21	88%	1.06	16%	0.18	96%	0.17	98%	1.01	73%	0.55	88%	0.10	92%	8	71%
SCVWD	0.53	94%	0.29	58%	0.20	88%	1.08	4%	0.18	94%	0.17	96%	1.21	37%	0.56	90%	0.11	79%	282	0%

TABLE 5-19
ESTIMATED AVERAGE CONCENTRATIONS OF METALS AT TURNOUTS TO LOCAL WATER DISTRIBUTION SYSTEMS

	SJ/SC WPCP [1] (µg/L)	Sunnyvale WPCP [2] (µg/L)	Palo Alto RWQCP [3] (µg/L)	Flow Weighted (µg/L)
Cadmium [6]	0.2	0.21	0.18	0.2
Chromium	5.9	0.031	0.37	4.5
Copper	6.7	1.03	1.01	5.3
Lead [5]	1.6	0.18	0.18	1.3
Mercury [4]	0.2	0.17	0.17	0.2
Nickel	1.1	1.09	1.03	1.1
Selenium [4]	1.0	0.56	0.56	0.9
Silver [4]	0.2	0.1	0.1	0.2
Zinc	166	121	55	145

Notes:
(1) Data from table 3-11 CH2M Hill, "Residential Sampling Program for the San Jose/Santa Clara Water Pollution Control Plant", February 1993. Nondetectable values set to the detection limit.
(2) Data from appendix EOA, Inc, "Update of Source Loadings to the City of Sunnyvale Water Pollution Control Plant", 1995 Annual Pretreatment Report. Nondetectable values set to the detection limit.
(3) Source concentration raw data same as (2). Flow proportions from Table 1 Copper and Selenium Steering Committee, "Copper and Selenium in the Water Supply of the Santa Clara Valley", January 1994.
(4) Majority of samples were nondetectable
(5) Majority of samples for Sunnyvale and Palo Alto were nondetectable.
(6) Majority of samples for SJ/SC were nondetectable

TABLE 5-20
SCVWD ZINC ORTHOPHOSPHATE CONTRIBUTION TO WATER SUPPLY TO INHIBIT CORROSION

SCVWD Treatment Plants	Influent 1994 Avg Zn Conc mg/l	Effluent 1994 Avg Zn Conc mg/l	Zn Ortho. contribution to Zn Conc mg/l
Rinconada	0.05	0.42	0.37
Penitencia	0.05	0.46	0.41
Santa Teresa	0.05	0.43	0.38
Average			0.39

Note:
Standard treatment plant dose = 0.4 mg/l for Rinconada, Penitencia and Santa Teresa

TABLE 5-21
MAJOR SOURCES OF METALS IN POTABLE WATER SUPPLY

Major Sources of Metals in Potable Water Supply	Flow	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury		Nickel		Selenium		Silver		Zinc	
	mgy	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr	conc µg/L	load lbs/yr
Source Water[1,2]	2,174	1.4	25	0.2	4	4.5	82	5.3	96	1.3	24	0.2	4	1.1	20	0.9	16	0.2	4	145	13
Copper Sulfate Addition																					
- SCVWD[3]	10							14.3	1												
- SFWD[4]	500							0.01	0.05												
Zinc Orthophosphate Addition[5]	804																			390	2618
Corrosion of Plumbing Materials	2,174							34	617	0.4	7										
Total			25		4		82		714		31		4[6]		20		16[6]		4[6]		2631

Notes:

[1] The mass from copper sulfate addition was subtracted from the mass calculated using this copper concentration value to present the contribution from source water.

[2] The mass from zinc orthophosphate addition was subtracted from the mass calculated using this zinc concentration value to present the contribution from source water.

[3] The flow was calculated by multiplying the total flow, 2,174 mgy, by the percent contributed by the Rinconada and Penitencia treatment plants, 24%, and the percent days of copper sulfate application, 2%.

[4] The flow was calculated by multiplying the total flow, 2,174 mgy, by the percent contributed by the SFWD, 23%.

[5] The flow was calculated by multiplying the total flow, 2,174 mgy, by the percent contributed by the SCVWD, 37%.

[6] Estimates based primarily on non-detectable measurements and therefore highly uncertain.

TABLE 5-22
ANNUAL LOAD ESTIMATES
MERCURY MINING SOURCES IN ALMADEN QUICKSILVER COUNTY PARK

Water Body	Average Mercury Concentration [ug/l]	Mean Annual Rainfall [in.]	Approximate Drainage Area [acres]	Mercury Load [lbs/yr]
	1.1	22		
Bay via Guadalupe River			2813	11
Almaden Reservoir			562	2
Guadalupe Reservoir			375	1

Calculation of Adjusted Annual Runoff Coefficient

Parameter	Result
C	0.2
C_s	0.49
C_i	1.10E-05
I_2 [hour^{-1}]	0.004
i [inches/hour]	0.088
Slope (%)	100
C'	0.69

TABLE 5-23
SUMMARY OF COPPER SOURCES TO THE BAY

Source	Estimated Load at Source[1] [lbs/yr]	Adjusted Load to Bay[2] [lbs/yr]	% of Total Load
Point	2,461	**2,461**	**28**
Estimated Nonpoint Load (Section 4)	6,400	6,400	72
Urban Nonpoint	9,611	**4,685**	**53**
Brake Pads	7,700	3,753	42
Coolant Leaks	112	55	1
Coolant Illegal Dumping	116	57	1
Oil Illegal Dumping	7	3	0
Industrial	693	338	4
Tailpipe Emissions	116	57	1
Construction Erosion	93	45	1
Pesticide/Fertilizer Application	74	36	0
Water Supply/Corrosion	700	341	4
Other Nonpoint (Natural Erosion and Reservoir Spills)	3,519	**1,715**	**19**
Total		**8,861**	100

Note:

[1] See individual sections for limitations affecting the estimated load from each source.

[2] Nonpoint source estimates adjusted to be consistent with nonpoint load estimates in Section 4.

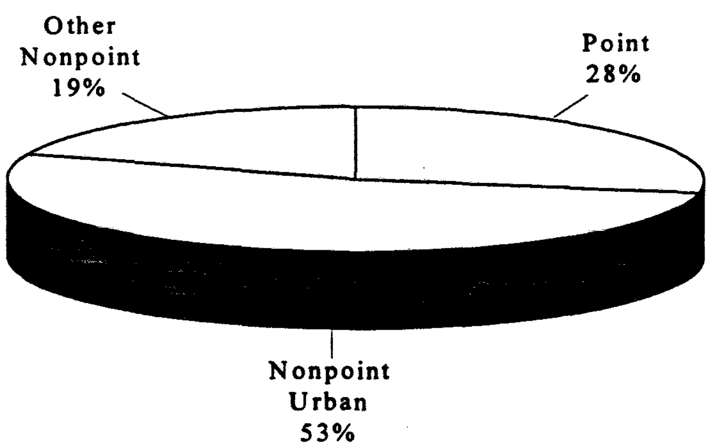
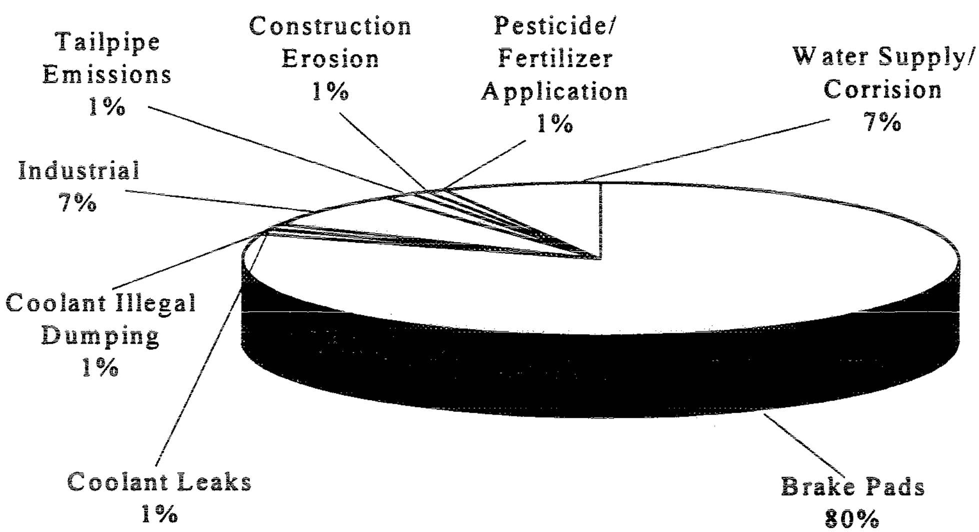


TABLE 5-24
SUMMARY OF URBAN NONPOINT COPPER SOURCES TO THE BAY

Source	Adjusted Load [lbs]	% of Total Load
Brake Pads	3,753	80
Coolant Leaks	55	1
Coolant Illegal Dumping	57	1
Oil Illegal Dumping	3	0
Industrial	338	7
Tailpipe Emissions	57	1
Construction Erosion	45	1
Pesticide/Fertilizer Application	36	1
Water Supply/Corrosion	341	7
Total	***4,685***	100



NOTE: See individual sections for limitations affecting the estimated load from each source.

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TABLE 5-25
SUMMARY OF NICKEL SOURCES TO THE BAY

Source	Estimated Load at Source [1] [lbs/yr]	Adjusted Load to Bay [2] [lbs/yr]	% of Total Load
Point	4,530	4,530	27
Estimated Nonpoint Load (Section 4)	12,140	12,140	73
Urban Nonpoint	1,184	2,224	13
Construction Erosion	198	372	2
Industrial Discharge and Runoff	509	956	6
Automotive	101	190	1
Tailpipe Emissions	335	629	4
Water Supply	20	38	0
Industrial Stack Emissions	21	39	0
Other Nonpoint (Natural Erosion and Reservoir Spills)	5,277	9,916	59
Total		16,670	100

Note:
[1] See individual sections for limitations affecting the estimated load from each source.
[2] Nonpoint source estimates adjusted to be consistent with nonpoint load estimates in Section 4.

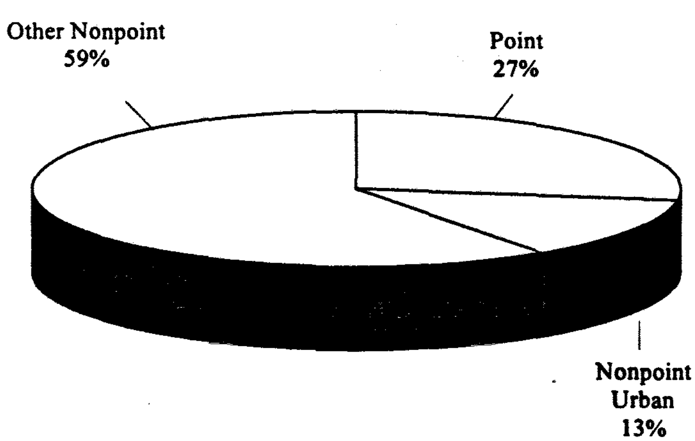


TABLE 5-26
SUMMARY OF URBAN NONPOINT NICKEL SOURCES TO THE BAY

Source	Adjusted Load to Bay [lbs/yr]	% of Total Load
Construction Erosion	372	17
Industry Discharge and Runoff	956	43
Automotive	190	8
Tailpipe Emissions	629	28
Water Supply	38	2
Industrial Stack Emissions	39	2
Total	*2,224*	100

Note: See individual sections for limitations affecting the estimated load from each source.

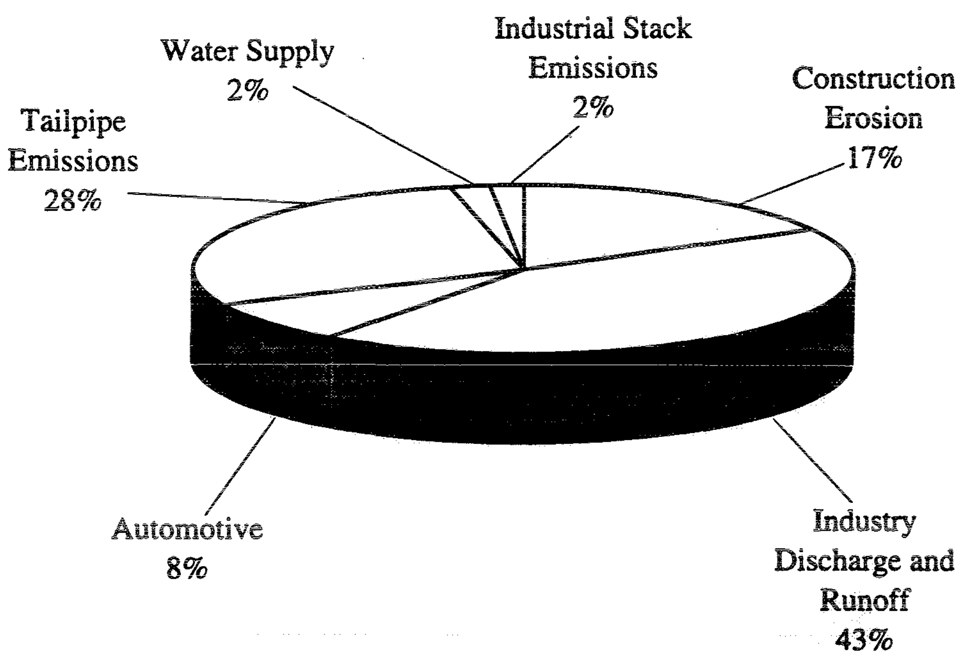


TABLE 5-27
SUMMARY OF MERCURY SOURCES TO THE BAY

Source	Estimated Load at Source[1] [lbs/yr]	Adjusted Load to Bay[2] [lbs/yr]	% of Total Load
Point	2.3	2.3	3
Estimated Nonpoint Load (Section 4)	73	73	97
Urban Nonpoint	40	31	42
Industry[3]	3	2	3
Tailpipe Emissions	32	25	33
Construction Erosion	1	1	1
Water Supply	4	3	4
Other Nonpoint	53	42	55
Mining[3]	11	9	11
Natural Erosion and Reservoir Spills[3]	42	33	44
Total		75	100

Note:
[1] See individual sections for limitations affecting the estimated loads from each source.
[2] Nonpoint source estimates adjusted to be consistent with nonpoint load estimates in Section 4.
[3] Loads from mining, industrial activity and reservoir spills were estimated using primarily non-detect data.

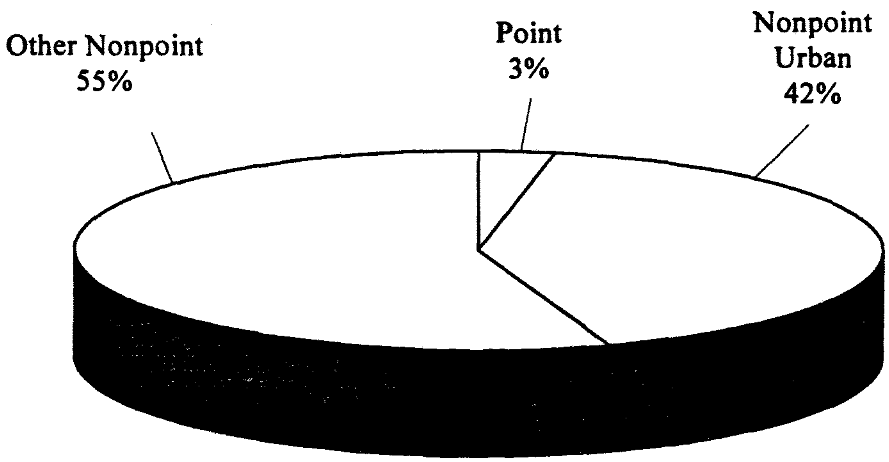
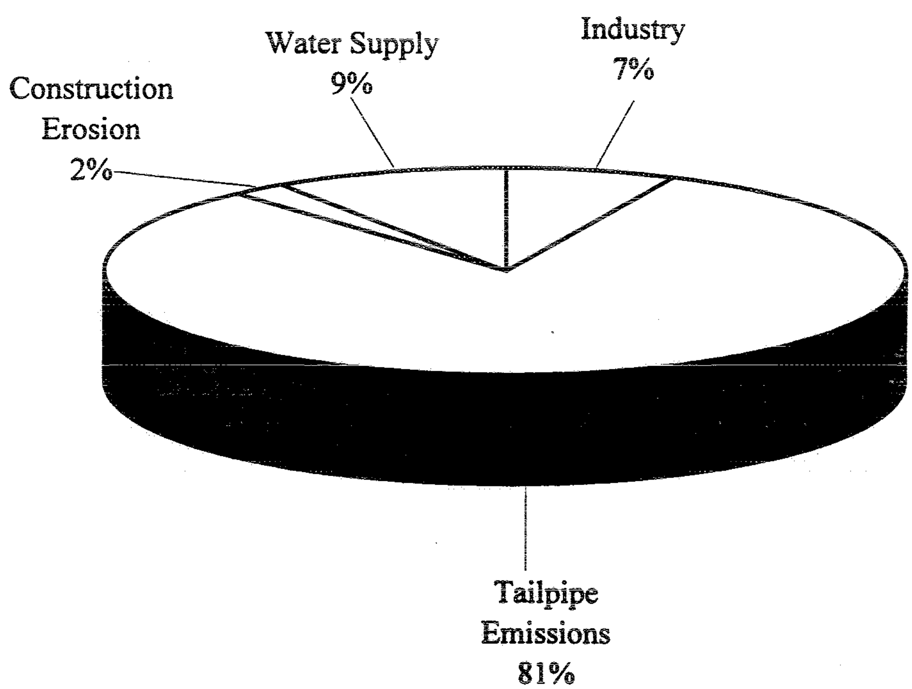


TABLE 5-28
SUMMARY OF URBAN NONPOINT MERCURY SOURCES TO THE BAY

Source	Adjusted Load [lbs]	% of Total Load
Industry	*2*	*7*
Tailpipe Emissions	25	81
Construction Erosion	1	2
Water Supply	3	9
Total	**31**	100

NOTE: Load from industrial activity was estimated using primarily non-detect data.



NOTE: See individual sections for limitations affecting the estimated load from each source.

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TABLE 5-29
SUMMARY OF SILVER SOURCES TO THE BAY

Source	Estimated Load at Source [lbs/yr]	% of Total Load
Point[1]	**416**	**86**
Estimated Nonpoint Load (Section 4)	**65**	**14** [2]
Urban Nonpoint	--	
Industry[1]	165	
Tailpipe Emissions	51	
Water Supply	4	
Other Nonpoint (Reservoir Spills)	149	
Total	**481**	86

Note:

[1] Loads from point sources and industrial activity estimated using primarily non-detect data. Also, see individual sections for limitations affecting the estimated load from each source.

[2] Percent total load was not estimated separately for urban and other nonpoint sources, due to uncertainty associated with the estimates.

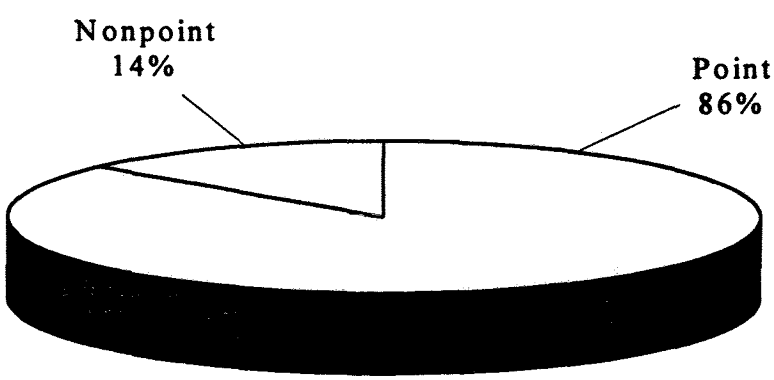

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TABLE 5-30
SUMMARY OF SELENIUM SOURCES TO THE BAY

Source	Estimated Load at Source [lbs/yr]	% of Total Load
Point[1]	**486**	**78**
Estimated Nonpoint Load (Section 4)	**137**	**22**[2]
Urban Nonpoint	--	
Industry[1]	127	
Construction Erosion	3	
Water Supply	16	
Tailpipe Emissions	58	
Other Nonpoint (Natural Erosion and Reservoir Spills)	106	
Total	**623**	**78**

Note:

[1] Loads from point sources and industrial activity estimated using primarily non-detect data. Also, see individual sections for limitations affecting the estimated load from each source.

[2] Percent total load was not estimated separately for urban and other nonpoint sources, due to uncertainty associated with the estimates.

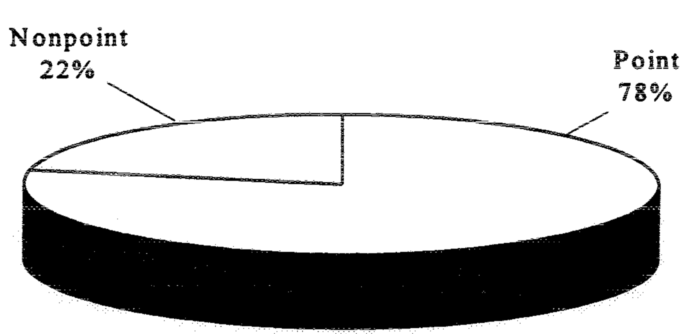

TABLE 5-31
SUMMARY OF LOADS TO THE BAY BY SOURCE (POLLUTANTS OF CONCERN)

Source	Percent Total Load				
	Copper	**Nickel**	**Mercury**	**Silver**	**Selenium**
Urban Nonpoint[1]	53	13	39		
Auto	44[2]	1	0		
Industrial	4	6	3		
Construction Erosion	1	2	1		
Water Supply	4	0	4		
Tailpipe Emissions	1	4	31		
Stack Emissions	0	0	0		
Other Nonpoint	19	60	58	14[3]	22[3]
Reservoir Spills and Open Space Erosion	19	60	28		
Point	28	27	3	86	78
Total	100	100	100	100	100

Notes:

(1) Less than one percent of the total copper load is from pesticide/fertilizer application.

(2) The majority of this load is from brake pads.

(3) This includes both urban and nonurban nonpoint sources. Percentages were not broken out due to uncertainty associated with the data used to estimate loads.

TABLE 5-32
OVERALL RANKING OF NONPOINT SOURCES FOR IMPROVED LOAD ESTIMATES

Copper

Urban Nonpoint Source	% of Total Load	Uncertainty	Uncertainty Rank	Overall Rank	
Brake Pads	42	Medium-High	4	1	
Water Supply/ Corrosion	4	High	5	3	
Industrial Discharge	4	Medium-High	4	4	Cutoff
Coolant leaks	1	Medium	3	5	
Coolant Illegal Dumping	1	Medium	3	6	
Construction Erosion	1	Medium	3	7	
Tailpipe Emissions	1	Medium	3	8	
Oil Illegal Dumping	0	Medium	3	9	
Pesticide/Fertilizer Application	0	Medium	3	10	
Industrial Stack Emissions	0	Low	1	11	

Non-Urban Nonpoint Source	% of Total Load	Uncertainty	Uncertainty Rank	Overall Rank
Natural Erosion/Reservoir Spills	19	Medium	3	2

Nickel

Urban Nonpoint Source	% of Total Load	Uncertainty	Uncertainty Rank	Overall Rank	
Industrial Discharge	6	Medium-High	4	2	
Tailpipe Emissions	4	Medium	3	3	Cutoff
Constriction Erosion	2	Medium	3	4	
Automotive	1	Medium	3	5	
Water Supply	0	High	5	6	
Industrial Stack Emissions	0	Low	1	7	

Non-Urban Nonpoint Source	% of Total Load	Uncertainty	Uncertainty Rank	Overall Rank
Natural Erosion and Reservoir Spills	59	Medium	3	1

Mercury

Non-Urban Nonpoint Source	% of Total Load	Uncertainty	Uncertainty Rank	Overall Rank	
Tailpipe Emissions	33	Medium	3	2	
Water Supply	4	High	5	4	Cutoff
Industrial Discharge	3	Medium-High	4	5	
Construction Erosion	1	Medium	3	6	

Other Nonpoint Sources	% of Total Load	Uncertainty	Uncertainty Rank	Overall Rank
Natural Erosion and Reservoir Spills	44	Medium	3	1
Mining	11	High	5	3

NOTE: Uncertainty Rank Key: Low = 1; Medium-low = 2; Medium = 3; Medium-high = 4; High = 5

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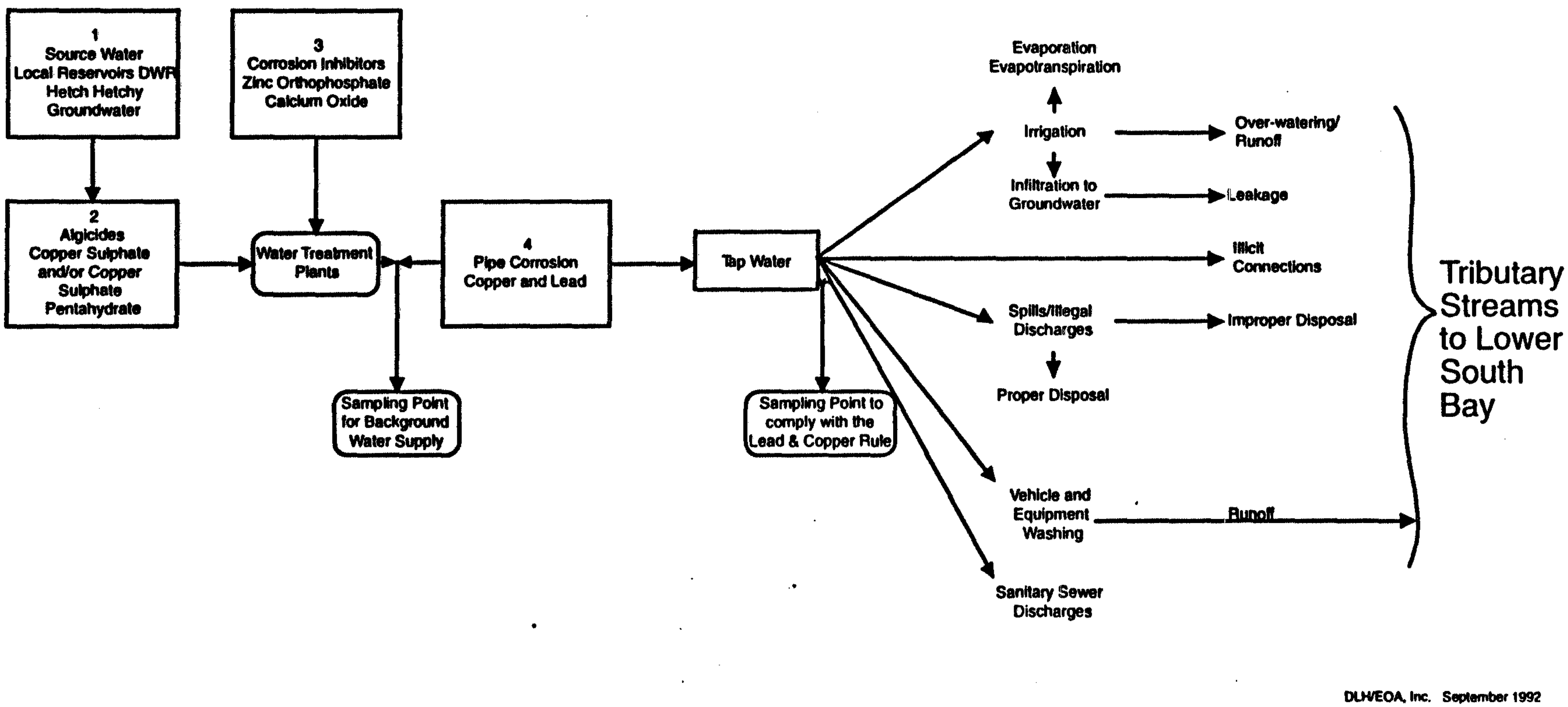

Project No. 951268NA	Santa Clara Valley Metals Control Measures Plan	FLOWPATH DIAGRAM FOR POTABLE WATER SOURCES	Figure 5-1
Woodward-Clyde Consultants			

92006/GMR/8720115J.o09

951277NA-WC-400/082096/graphics/mci

Chapter 5 identifies the following pollutant metals of concern from urban sources:

- Copper from brake pads
- Copper, nickel and mercury from industrial sources
- Mercury and nickel from tailpipe emissions
- Nickel from construction site erosion
- Nickel from industrial air emissions

This Metals Control Measures Plan emphasizes control of these sources with special emphasis on copper because of the significance of urban copper sources, and because many of the controls for copper also address nickel, mercury, and other metals.

Section 6.1 briefly reviews the Program's previous efforts to develop measures specifically aimed at controlling copper loading and the status of some of those measures.

Section 6.2 describes how, under the 1994 Storm Water Management Plan (1994 SWMP), the co-permittees have pursued a comprehensive set of activities that are intended to reduce the quantity of pollutants, including metals, entering storm drains. Ongoing efforts include street sweeping, storm drain cleaning, maintenance of corporation yards and other municipal facilities, enforcement of erosion control measures at construction sites, regulation of development, prevention of illicit discharges, inspection of industrial and commercial facilities, and monitoring of the drainage system.

Section 6.2 also describes the status of the preparation of Performance Standards for many of the ongoing control activities. The Program's 1995 NPDES permit required preparation and submittal of Performance Standards — defined as "the level of implementation necessary to demonstrate the control of pollutants in storm water to the maximum extent practicable" — for many ongoing pollution-prevention activities.

During 1996, the Program's Management Committee adopted, and submitted to the Regional Board, Model Performance Standards for

- Illicit Discharge and Illegal Dumping Elimination,
- Industrial/Commercial Discharger Control,
- Public Streets, Roads and Highways Operation and Maintenance,
- Storm Drain Systems Operation and Maintenance,
- Water Utility Operation and Maintenance,

- Planning Procedures, and
- Construction Site Inspection.

In addition, the Program continues to educate the public about the importance of, and techniques for, urban runoff pollution prevention.

Section 6.2 also assesses the costs of these measures relative to their effectiveness in reducing metals loading.

Section 6.3 summarizes additional controls, to be implemented by the co-permittees, that will achieve further reductions in metal pollutants reaching storm drains.

Section 6.4 describes the Program's participation in regional cooperative efforts and initiatives that will further reduce metals from urban or non-urban sources. With respect to non-urban sources, the Program is participating in the Santa Clara Basin Watershed Management Initiative (WMI) which is intended to address non-urban upland pollutant sources.

Section 6.5 describes how the new metals control measures will be integrated into the Program's 1997 Urban Runoff Management Plan (URMP). The URMP outlines a process for ongoing investigation and continuous improvement of the Program's efforts to reduce metals loading to San Francisco Bay.

6.1 PREVIOUS DEVELOPMENT OF METALS CONTROL MEASURES

The Program has participated, along with other permitted dischargers, in strategies to control the total mass of toxic metals discharged to the the Lower South Bay. These strategies are described below.

6.1.1 Copper Control Action Plan (1992)

In 1992, the Program prepared a *Source Identification and Control Report* which classified metals sources and assigned priorities for implementing controls. The report contained a "Copper Control Action Plan", which specified the following measures to control sources of copper.

TABLE 6-1
1992 COPPER CONTROL ACTION PLAN

SCM-A1	Reduce Vehicle Miles Travelled
SCM-A2	Promote Use of Cleaner Alternative Fuels
SCM-A3	Lower Emission Standards for Particulate Emissions from Diesel Exhaust
SCM-B1	Reduce the Amount of Copper in Brake Pads
SCM-E1	Monitor Progress of Water Purveyors in Identifying and Controlling Metals Sources

6.1.2 Draft Memorandum of Understanding with POTW Dischargers (1994) ("Copper Reduction Dialogue")

In June 1993, the Regional Board developed a Waste Load Allocation (WLA) for NPDES-permitted copper discharges to San Francisco Bay. A WLA is the portion of a receiving waters' assimilative capacity that is allocated to one of its existing or future point sources of pollution (40 CFR 130.2(g)). The WLA was intended to reduce overall copper loading sufficiently so that Lower South Bay ambient copper concentrations would meet water quality objectives. (The WLA has since been remanded by the State Water Resources Control Board.)

In response to the WLA, the Program initiated a "copper reduction dialogue" that included regulatory, environmental and commercial interest groups. As a result of this dialogue, the Program drafted a Memorandum of Understanding (MOU) with Lower South Bay POTW dischargers (the cities of San Jose, Palo Alto and Sunnyvale). The MOU aimed to "lead to a 950 pound annual load reduction discharges of copper...." (James 1994). The draft MOU's Appendix A described control measures to be considered for implementation by the co-permittees.

Table 6-2 describes the implementation status control measures, including those that are the subject of Performance Standards, identified in the 1994 MOU.

TABLE 6-2
CURRENT STATUS OF CONTROL MEASURES
IN 1994 COPPER REDUCTION DIALOGUE MOU

No.	Control Measure	Status
1	Control copper discharges from agency-sponsored construction projects	Standard language for construction contracts is used by some co-permittees.
2	Control discharge from building maintenance activities	Program is cooperating with BASMAA in a regional program to train and certify mobile cleaners.
3	Control commercial facilities discharge	Model Performance Standard calls for inspections every 2 years.
4	Control commercial vehicle services facilities discharge	Model Performance Standard calls for inspections every 2 years.
5	Control cooling tower discharge	Addressed by co-permittees' prohibitions on non-storm water discharges to storm drains.
6	Reduce copper sulfate use by water suppliers	POTW dischargers have worked with water suppliers to minimize dosage.
7	Control erosion	Co-Permittees have adopted Performance Standards for Construction Inspection. Through BASMAA, the Program is working with Regional Board staff on a handbook, and on training and certification, for erosion control inspectors.
8	Control copper discharge from food handling establishments	Performance Standards call for inspections every three years.
9	Control copper discharge from household hazardous waste (HHW) program.	Co-permittees support the countywide HHW Program.
10	Conduct industrial inspections	Performance Standards specify frequency and content for industrial inspections.
11	Control copper discharge from metal fabrication facilities	Performance Standards specify frequency and content for industrial inspections. See additional control measure INDUSTRIAL-1 (Sec. 6.3)
12	Manage storm water through POTWs	Will continue to be considered, but review by one co-permittee shows effectiveness/applicability may be limited.
13	Control the discharge of copper-based root control chemicals to storm drains	The Program helped the legislative effort that led to permanent ban on sale and use.
14	Control copper discharge to Bay through spill response and clean up	In addition to spill response and clean-up, co-permittees are implementing Performance Standards for Illicit Discharge and Illegal Dumping Elimination.

TABLE 6-2
CURRENT STATUS OF CONTROL MEASURES
IN 1994 COPPER REDUCTION DIALOGUE MOU

No.	Control Measure	Status
15	Reduce the amount of copper contained in brake pads	The Program is supporting efforts by Common Ground for the Environment to establish a Brake Pad Partnership.
16	Quantification activities	This report is a contribution to quantification of metals loads.
17	Reduce vehicle miles travelled and mitigate added impervious surface area from roads and parking.	The Program continues to work with the Congestion Management Agency. Through BASMAA, the Program helped develop *Start at the Source,* a design manual that encourages minimizing impervious area.
18	Strengthen existing institutional arrangements for watershed protection	Program and co-permittees are helping to develop the Santa Clara Basin Watershed Management Initiative.
19	Identify new copper sources for control measure applications	This report identifies sources and prioritizes actions based on contribution to total loading. The Program will respond to new information about sources and seek new opportunities to control known sources.
20	Control copper corrosion from potable water discharges	Three co-permittees have, through their POTWs, worked with the San Francisco Water Department and the Santa Clara Valley Water District to reduce corrosivity of potable water, and to optimize zinc orthophosphate dosages.
21	Control copper discharged from application of copper-based pesticides	Co-permittees rigorously adhere to Dept. of Pesticide Regulation requirements. Program has helped educate the public about minimizing pesticide use.
22	Reduce copper in sediment	Addressed through control of sources.
23	Conduct street sweeping	On-going activity, addressed in Performance Standards.
24	Improve design, operation and maintenance practices	Co-permittees implement Performance Standards for O&M of public streets and roadways, and O&M of storm drains.
25	Watershed classification for South Bay	To be addressed through the Watershed Management Initiative.

6.2 ONGOING AND PLANNED CONTROLS IMPLEMENTED BY THE PROGRAM TO ADDRESS METALS

Various studies over the past 30 years have documented the presence of copper, lead and zinc in roadside dirt. Many Program activities reduce, to some extent, the amount of these metals that reach the Bay. Most of these measures are mandated by state and Federal regulations (EPA's 1990 storm water regulations, the Regional Board Basin Plan, and provisions of the Program's NPDES permit).

The 15 agencies (co-permittees under the NPDES permit issued to the Program) implement control measures within their own jurisdictions. A Management Committee, composed of co-permittee representatives, directs implementation of joint Program activities.

Most control measures involve implementation of Best Management Practices (BMPs). The BMPs are designed to reduce the amount of all potential pollutants, including copper and other metals, entering storm drains. The co-permittees have implemented many of these BMPs since the Program's inception.

Table 6-3 summarizes the co-permittees' current implementation of these control measures. Implementation actions are summarized from Tables 9.7.1 through 9.7.10 in the Program's December 1994 *Proposed Storm Water Management Plan for NPDES Permit Period 1995-2000* (1994 SWMP). Tables and accompanying text in that document explain implementation tasks more fully. Table 6-3 also includes information, where applicable, about the sources addressed by the measure, and the measure's effectiveness in controlling metals.

TABLE 6-3
CONTROL MEASURES IN THE 1994 SWMP

Control Measure	Program/Co-Permittee Actions	Sources and quantities addressed; effectiveness
Public Agency Activities		
PAA-1	Prepare and implement SWPPPs for Municipal Corporation Yards.	Addresses portion of total industrial load
PAA-2	Parks and Recreation: Implement BMPs for storage/use of fertilizers/pesticides, wash water, maintenance activities, swimming pools.	Fertilizers/Pesticides account for <1 percent of copper.
PAA-3	Storm drain inlet maintenance, line maintenance, solid waste and debris management, research opportunities for structural retrofits.	Annual cleaning removes perhaps 2 percent of total copper load.
PAA-4	Street sweeping/cleaning; improve sweeping effectiveness; implement BMPs for pavement washing, saw cut slurry, paving, median irrigation & pesticide use.	Frequency of sweeping varies with jurisdiction and land use. Sweeping 1-2x monthly removes perhaps 5 percent of total copper load from streets.
PAA-5	Flood Control: Coordinate with NDC element; inventory all key O&M activities; evaluate and implement opportunities to reduce use of pesticides, manage sediment, protect and restore vegetation, and improve fisheries management.	Controls metals from pesticides.

TABLE 6-3
CONTROL MEASURES IN THE 1994 SWMP

Control Measure	Program/Co-Permittee Actions	Sources and quantities addressed; effectiveness
PAA-6	Water Utility Operations: Coordinate with NDC element; inventory key O&M activities; identify routine & unplanned stowmwater discharges, discharges of chemical additives; evaluate impacts, develop and implement management plan.	Potable water accounts for 4 percent of Copper† <1 percent of Nickel† 2 percent of Mercury†
PAA-7	Public Facilities: Implement parking lot BMPs; manage discharges from golf courses, hospital sites, and other public buildings, plazas, and landscaping.	Effectiveness of treatment controls is limited.
PAA-8	Public Water Bodies: BMPs to control algae, chlorine and pollutant discharges.	Use of copper has been deterred; effectiveness in improving water quality unknown.
Public Information/Participation		
PIP-1	Develop a Program PIP Strategy for 1995-2000	Planning Task
PIP-2	General Outreach: Participate in BASMAA Regional Advertising Campaign; written materials, audio, video. Develop strategy to support WMM element.	Some effectiveness in reducing illicit discharges
PIP-3	Targeted Outreach: Residential education; commercial/light industrial outreach, support other Program elements.	
PIP-4	School education and general public education programs.	
PIP-5	Citizen Participation: Pilot Streamkeepers program, support citizen monitoring.	
Metals Control Measures		
MET-1	Copper Load Reduction: Refine loads estimates and assign Caltrans load reduction responsibilities. Plan implementation of MOU.	Planning Task‡
MET-2	Other Metals: Refine load estimates, develop and implement control measures. quantify reduction estimates.	Planning Task‡
Watershed Management Measures		
WMM-1	Institutional Arrangements: Define program goals.	To be conducted as part of WMI
WMM-2	Watershed Monitoring: Goals, sampling design, protocols, data management plan. Initiate pilot monitoring.	To be conducted as part of WMI
WMM-3	Watershed Classification: Review CONCUR Watershed Classification Paper; classify watersheds.	To be conducted as part of WMI

TABLE 6-3
CONTROL MEASURES IN THE 1994 SWMP

Control Measure	Program/Co-Permittee Actions	Sources and quantities addressed; effectiveness
WMM-4	Pilot Watershed Management Plan. Coordinate and evaluate pilot project; develop model watershed plan.	To be conducted as part of WMI
WMM-5	Area-Wide Watershed Management: Develop management strategy and plan.	To be conducted as part of WMI
Illicit Discharge Control Measures		
ICID-1,2,3	Illegal Discharge Elimination. Prioritize discharges, develop outreach materials, implement incident response plan, conduct inspections/surveys Prioritize inventory of commercial/industrial facilities, develop enforcement authority, plan and perform inspections and surveillance.	Illegal discharges account for 3 percent of Copper and <1 percent of Nickel
IND-1,2,3	Commercial/Industrial Inspections: List facilities, develop tracking/reporting database, develop outreach/BMP guidance materials, inspector training program, cooperation with other agencies to conduct inspections, evaluate feasibility of commercial awards program, parking lot BMPs and control strategy. Develop performance standards for industrial facilities.	SWRCB-permitted industrial sources account for 4 percent of Copper†, 5 percent of Nickel† and 1 percent of Mercury†
New Development and Construction Measures		
NDC-1	Planning Procedures: Integrate Program/CZARA/CCMP goals into project planning and design; revise project approval procedures; analyze development potential; incorporate storm water quality issues into General Plans and CEQA processes; use WMM model watershed plan, investigate use of new BMPs on public agency projects	Reducing impervious area could help prevent direct transport of some metal-laden dust to storm drains.
NDC-2	Permitting/Design: Establish minimum standards and BMPs for construction/ postconstruction controls, including erosion and sediment controls. Incorporate BMPs into project permit requirements. Require projects covered by statewide NPDES Permit to file for coverage. Coordinate with other Program elements.	
NDC-3	Education and Outreach: Coordinate with PIP element; dedvelop outreach materials for contractors, developers and designers.	
NDC-4	Construction Control Activities: Adopt procedures consistent with statewide NPDES permit and existing inspection programs. Inspection and enforcement of BMPs.	Construction erosion accounts for <1 percent of Copper; 2 percent of Nickel, <1 percent of Mercury

TABLE 6-3
CONTROL MEASURES IN THE 1994 SWMP

Control Measure	Program/Co-Permittee Actions	Sources and quantities addressed; effectiveness
NDC-5	Postconstruction Control Activities: Coordinate with local flood control agency re: postconstruction BMPs; O&M program for postconstruction BMPs.	Indirect relationship to metals control.

† Estimates have high uncertainty. See discussion in Section 5.0.

‡ Planning tasks may result in future control measures or in enhancements to existing measures, but do not directly address sources or reduce metals loading.

6.2.1 Public Agency Activities

Public agency activities include street sweeping and catch basin/storm drain cleaning. These activities can directly remove substantial quantities (although a limited part of the total) of copper and other metals. This category of activities also includes litter control, erosion control, leaf collection, management of pesticide application, waste recycling and cleaning of storm water detention basins. Municipalities have also implemented Storm Water Pollution Prevention Plans (SWPPPs) at corporation yards to reduce pollutants including metals in storm water runoff from those facilities.

Street sweeping and storm drain cleaning intercept an unknown proportion of brake pad dust and other metal-laden particles before rain can wash the associated pollutants into storm drains and the Bay. In 1994-95, Program co-permittees reported removal of an estimated 118,000 cubic yards of material via street sweeping and an additional 3,600 cubic yards of debris from catch basins, storm drain lines and detention basins (SCVNPSPCP 1995). Based on typical density and average concentrations of copper found in debris (Alameda County 1994) this material probably contained on the order of 250 pounds of copper, or about 2 percent of the total loading from urban sources.

Results from street sweeping studies suggest that copper-laden dust from roadways and other paved surfaces is affected by various factors. Prevailing winds and vehicle wakes move dust from place to place; dust settles in quiescent areas only to get blown about again. Dirt accumulates rapidly on the street surface immediately following a rain or sweeping, but accumulation decreases over time. The proportion of total fine particulates removed by street sweeping is highly variable and difficult to control. Typical street sweeping frequencies (once or twice per month) remove less than 5 percent of total solids and heavy metals in urban runoff (Alameda County 1994a).

Another option for removing additional copper is to clean drain inlets or catch basins more frequently. One study suggests that it may be possible to reduce annual pollutant load from street runoff from 2 percent to up to 10 percent by increasing cleaning frequency from once a year to

three or four times per year (Pitt et al. 1981). However, another study found that there is no significant increase in the load of copper removed unless cleaning frequency is increased to monthly. Even then, the decrease in load is dependent on removing "hot spots" that may be associated with illegal dumping (Alameda County 1994b).

The Program has prepared a model Performance Standard for Public Streets, Roads and Highways that calls for each municipal agency (and its contractors, if any) to implement appropriate BMPs for street sweeping and inlet cleaning activities. The Program has also developed a model Storm Drain System Operation and Maintenance Performance Standard that calls for inspection and cleaning (as needed) of the entire system every two years and inspection and cleaning of known problem areas annually. This performance standard also calls for agencies to avoid discharge to storm drains when dewatering debris collected by these cleaning activities.

6.2.2 Public Education/Participation

The Program attempts to influence individual behavior by informing citizens, business owners and employees of the effects of storm water pollution, and of techniques for preventing it. This Program element can help reduce illegal dumping. Some public education materials also emphasize reducing automobile use — to prevent water pollution, as well as air pollution.

There is survey evidence that ongoing pollution-prevention education can reduce the frequency of storm-drain dumping incidents. In a follow-up survey to a 1993 advertising campaign, nearly one-third of Alameda County residents surveyed reported that they have changed, in some way, to less polluting behavior (Russian Hill Associates 1994).

The Program's public education element focusses on changing the behavior of individual residents. Some aspects also address the behavior of employees in commercial and industrial businesses. Although this education is essential, some behaviors that are linked to a major pollutant sources are largely beyond individual control. (For example, automobile use is largely determined by land use patterns, job/housing balances and availability of public transportation.) Education aimed at changing individual behaviors has little potential to reduce major pollutant sources, such as automobile use.

Co-permittees' public education efforts to reduce pesticides and fertilizers entering storm drains have been targeted to homeowners and consumers. In 1994-1995, the Program distributed approximately 4,000 copies of *Pests Bugging You?*, a brochure which advocates less-toxic pest control, and *Take Me Shopping*, a resource guide of less-toxic consumer products (SCVNPSPCP 1995). The Program's efforts to educate consumers regarding the use of household toxic products may also reduce the use of organophosphate pesticides, particular diazinon and chlorpyrifos. These pesticides are acutely toxic to aquatic organisms in concentrations that have been found in storm water.

A more comprehensive accounting of purchase and use of copper-containing pesticides would be needed to assess the potential effectiveness of education as a control measure to reduce metals. Although pesticide-free agriculture, landscaping and gardening are gaining in popularity, there has been no assessment of any corresponding region-wide reductions in pesticide use. Because pesticides are a minor source of copper loading, even substantial reductions from present use, or implementation of best management practices to avoid runoff, will have little overall effect on copper loading.

6.2.3 Metals Control Measures

These measures include various activities, some of them regulatory, that specifically aim to reduce metals loading to the Bay. The 1994 SWMP describes objectives and a planning process to develop specific control measures.

MET-1, Task 1 in the 1994 SWMP calls for assigning Caltrans the responsibility for controlling its share of pollutant runoff from streets and roads. This is, of course, an administrative device. Caltrans will conduct some highway sweeping and storm drain cleaning of their facilities, but not as frequently as the co-permittees. The effectiveness in reducing metals loading would be similar to that of other street-sweeping and storm-drain-cleaning efforts.

MET-2, a planning task, calls for refining estimates of metals loading to the Bay. This report is a contribution to that effort. A discussion of priorities for future studies appears in Chapter 5.

6.2.4 Watershed Management Measures

This new element was added to the 1994 SWMP. The Program has since elected to pursue watershed management measures through support for, and involvement with, the Santa Clara Basin Watershed Management Initiative. (See Section 6.4.)

6.2.5 Illicit Discharge Control

Oil, coolant and other automotive fluids, along with paint and other construction-related debris, are among the most common, and most toxic, materials found in storm drains. Illicit discharges can have immediate, near-field effects on local streams. However, the source identification in Section 5 shows that, on a watershed-wide, annual basis, illegal dumping contributes a minor proportion of the total load of copper and other metals from urban nonpoint sources.

Co-permittees already thoroughly inspect their storm drain systems for illegal discharges and investigate, follow-up and enforce appropriately. Because illegal dumping constitutes a relatively small copper load, expanding efforts to reduce illicit discharges would have minimal effect on overall copper loading.

The Program has prepared a model Performance Standard for Illicit Connection and Illegal Dumping (ICID) Elimination Activities. The ICID Performance Standard includes specific actions that the co-permittees will implement in the areas of:

- resource commitment
- training/education/outreach
- complaint referral/incident response
- field investigation
- enforcement/follow-up and
- record-keeping/evaluation.

The performance standard also calls for annual review and evaluation of the effectiveness of activities contained within each co-permittees' ICID program.

6.2.6 Industrial Discharges

Co-permittees conduct periodic inspections at industrial facilities to assess whether potential non-storm water discharges have been eliminated and whether best management practices are being implemented. Inspectors look for evidence of past or potential discharges to storm drains (e.g. materials poorly stored, liquids not propoerly stored, or lack of provisions for capturing and disposing of process wastes). Co-permittees have eliminated many actual and potential industrial discharges, as evidenced by enforcement actions against egregious or repeat offenders. Facilities covered by the statewide storm water general permit for industrial activities must prepare and implement a Storm Water Pollution Prevention Plan (SWPPP).

Under the direction of the Management Committee, the Program supports the co-permittees' industrial inspection programs by:

- Distributing "no dumping" stencils for industries to use on private storm drains,
- Distributing Industrial Storm water Pollution Control Compliance Handbooks, and
- Assisting industries with permit compliance questions via a toll-free telephone hotline.

Some storm water inspections are combined with industrial pretreatment inspections, or done in cooperation with agencies conducting environmental health or hazardous materials inspections. All co-permittees with jurisdiction over commercial and industrial businesses reported that they conducted inspections during 1994-1995. Several added staff for this purpose. Countywide expenditures for industrial inspections to control storm water pollutants amounted to $1.3 million (SCVNPSPCP 1995).

The Program has developed a model Performance Standard for the co-permittees' Industrial/Commercial Discharger (IND) Programs. The IND Performance Standard calls for each co-permittee to complete an initial storm water inspection, within one year of beginning implementation of the Performance Standard, of all facilities that have filed a Notice of Intent (NOI) to be covered under the statewide storm water permit for industrial activities. "Significant" NOI dischargers are to be inspected annually. Other industrial facilities, and commercial facilities, are to be inspected every two or three years.

6.2.7 Construction Phase Controls

Since the 1970s, construction site erosion has been acknowledged as a significant source of storm water sediments. Beginning in the early 1980s, the RWQCB encouraged development of standards for erosion and sediment control, as well as training for project designers and construction site inspectors. ABAG produced a Manual of Standards for Erosion and Sediment Control in 1981, which was updated in 1995 (ABAG 1995).

Beginning in 1993, the Bay Area Storm water Management Agencies Association (BASMAA) formed a New Development Subcommittee and began work on a regionally consistent approach to controlling pollutants from construction and new development. In April 1994, Regional Board staff distributed *Recommendations for New and Redevelopment Controls for Storm water Programs* (RWQCB 1994). The Staff Recommendations, in effect, that each Bay area municipality review and, where necessary, strengthen enforcement of erosion control measures at construction sites.

Table 6-4 summarizes the Program's current and planned efforts to reduce erosion at construction sites. Under its current 5-year NPDES permit, the Program plans to strengthen outreach, inspection and enforcement. Performance Standards for planning procedures and construction inspection are currently being implemented.

TABLE 6-4
CURRENT AND PLANNED ACTIVITIES TO STRENGTHEN EROSION CONTROL AT CONSTRUCTION SITES

Control Measure	Examples Of Current Implementation	Control Measures in 1994 SWMP and Copper Reduction Dialogue	Performance Standards and 1997 URMP
Planning and Plan Review	Co-permittees include erosion and sediment controls in construction site inspections	Establish minimum standards and BMPs (NDC-2, Task 1)*	Co-permittees' Performance Standards for planning procedures specify an erosion and sediment control
	Co-permittees require, as a condition of permits, that developers incorporate BMPs into plans and specifications	Review and revise existing permit requirements (NDC-2, Task 1)*	plan for all wet-season construction activity where project creates potential for erosion and that developers demonstrate coverage under
	Co-permittees require compliance with State NPDES permit for construction activities	Make a condition of local approval. (NDC-2, Task 3)*	State General Construction Activity Storm Water Permit, where applicable.
Training and Education	Workshops for staff on erosion control techniques.	Staff training (NDC-3, Task 1)*	Co-permittees' Performance Standards for construction inspection specify annual
	Created the booklet *Blueprint for a Clean Bay* and brochures describing BMPs for various construction activities.	Develop outreach materials for contractors, developers and designers (NDC-3, Task 2) .*	training of construction inspection staff.
Inspection and Enforcement	Co-permittees include erosion and sedimentation control in building or public works inspections	Adopt inspection procedures (checklists, enforcement, reporting) (NDC-4, Task 1).*	Co-permittees' Performance Standards for construction inspection specify inspection of all active sites with erosion and sediment control requirements during
		Inspection and enforcement (NDC-4, Task 2)*, Increase enforcement (#7) †	wet season and following major storms.

TABLE 6-4
CURRENT AND PLANNED ACTIVITIES TO STRENGTHEN EROSION CONTROL AT CONSTRUCTION SITES

Control Measure	Examples Of Current Implementation	Control Measures in 1994 SWMP and Copper Reduction Dialogue	Performance Standards and 1997 URMP
Agency Construction Projects		Include erosion control BMPs in contract documents (#1)†	Co-permittees' Performance Standards for Planning Procedures specify that capital improvement projects include control measures.

*Refers to elements and tasks in the Program's 1994 Storm Water Management Plan.
†Refers to control measures in the South Bay Copper Reduction Dialogue Progress Report (1994).

Current and planned control measures, if rigorously applied, can be very effective in reducing sediment loss from a given site. Construction erosion contributes comparatively minor amounts of copper, nickel and mercury. Control measures could achieve small, but significant, reductions in overall loading, particularly for nickel.

Construction erosion causes site-specific, transient, peaks in turbidity and total suspended solids, which can affect some aquatic species. Also, construction erosion contributes to siltation, which can have a critical impact on spawning of salmonids. Erosion control should be motivated primarily by the need to avoid near-field effects of turbidity and siltation, rather than control of metals toxicity in the open waters of the Bay.

The Program has previously reported that "Erosion Control Program Reviews have not been implemented as a distinct item, although erosion and sediment controls are included in most co-permittees' codes, legal authority exists, and outreach efforts have been on-going" (SCVNPSPCP 1995). Although the co-permittees have done much to reduce erosion from construction sites, the Program has acknowledged that erosion control can be improved in hillside residential areas.

6.2.8 Site Planning and Post-Construction Controls

Ongoing urbanization of the Santa Clara Valley Watershed will tend to increase the total amount of runoff and the mass of copper and other metals dissolved or suspended in runoff. Modelling by the San Francisco Estuary Project predicted that copper loads could increase by 5% to 14% as a result of growth projected for 1990-2005 (San Francisco Estuary Project 1992).

Brake pads shed copper as a fine dust. When this dust settles on impervious surfaces — streets, parking lots and roofs — it can then be washed into storm drains. Site planning controls and post-construction best management practices (BMPs) focus on reducing impervious area and avoiding direct, paved or piped connections to storm drains. This can reduce the amount of brake pad dust and other metals that reach the Bay.

Co-permittees have instituted changes in planning policies and development review procedures (SCVNPSPCP 1995). These can benefit reduction in copper loading in two ways: (1) by reducing impervious area, and (2) by reducing overall vehicle miles travelled.

The quantity and distribution of paved vs. unpaved landscape affects the fate of brake pad dust, but to an unknown degree. Dust that settles on landscaped or undeveloped areas may be permanently prevented from reaching storm drains. Dust may become incorporated into the matrix of soil and organic material, resulting in an insignificant increase over the background concentration of copper in soils. Conversely, paved areas, including building roofs, allow ready transport of air-deposited dust into storm drains with the next rain.

The Regional Board *Staff Recommendations for New and Redevelopment Controls for Storm Water Programs* (RWQCB 1994) specify post-construction BMPs intended to reduce the amount of pollutants that travel from impervious surfaces into storm drains. These BMPs affect runoff from new development only (not existing development). So far, only a few projects have had post-construction storm water pollution controls incorporated as conditions of approval.

Reduction in impervious area—particularly impervious area that is directly connected to the drainage system—has a direct, and perhaps proportional, effect on copper loading from vehicular sources. However, these reductions apply only to *additional* impervious area associated with new development. The opportunity for reduction of impervious area in already-urbanized areas is very limited.

Within the incorporated area under the co-permittees' jurisdiction, there are about 143,000 urbanized acres (ABAG 1994a). About 17,400 developable acres remain (ABAG 1994b). Even if all this developable area were built out, the total urbanized area would increase by only 12 percent. Clustering and other development mitigations can potentially reduce impervious area by 10-50 percent (City of Olympia 1996). So the total reduction in ultimate impervious area that might be achieved through development mitigations is 1-6 percent, and this would be achieved over 15-25 years.

6.2.9 Summary of Costs and Effectiveness of Current Control Measures

The Program reported expenditures of $16.8 million for fiscal year 1994-1995. These expenditures include storm drain inspections and illegal dumping elimination ($1.1 million), public education ($0.5 million) and operation and maintenance of public facilities ($8.6 million), including street sweeping and storm drain cleaning.

The proportion of total copper loading that is currently addressed by illegal dumping controls, public agency activities and other existing control measures is limited because (1) the sources addressed are a small proportion of the total loading, and (2) there are inherent limitations to controlling fine particulate metals once they have been released to the environment. Despite a large expenditure of resources, the Program is currently able to control a relatively small

proportion of copper loading. However, existing control measures benefit the urban environment, and the natural environment, in many other ways.

6.3 PROGRAM COMMITMENT TO IMPLEMENT ADDITIONAL METALS CONTROL MEASURES

This section describes additional measures that the Program will implement that specifically focus on sources of metals that have been identified as relatively important and are within the jurisdiction of the Program.

6.3.1 New Control Measures to Reduce Copper, Nickel and Mercury from Industrial Sources

The Program's reports demonstrate that industrial inspections are broad-reaching and thorough. However, the available self-monitoring data indicate that electroplating, metal finishing and semiconductor manufacturing facilities may have high copper and nickel concentrations in runoff.

The apparent high concentrations in industrial runoff may be due to one or more of the following:

- Industrial storm water runoff is self-monitored, and quality assurance certification is not transmitted with the analytical data, which may be inaccurate.
- Runoff concentrations may be elevated, due to spills, leaks and poor housekeeping practices.
- Runoff concentrations are elevated, but the cause is a pathway (e.g. air deposition) that is not currently considered during inspections.

The following two additional measures will be implemented by the Program to assist in improved control of industrial sources.

INDUSTRIAL-1	Assist industry, on a pilot program basis, to develop storm water sampling and analysis protocols and conduct independent spot-checking to verify SWRCB industrial data.
INDUSTRIAL-2	If relatively high concentrations of metals in runoff from targeted industrial categories are confirmed, collaborate with industry to investigate potential pathways and develop appropriate BMPs.

Industrial sources subject to NPDES storm water regulation contribute a relatively small, but significant, load of copper to South San Francisco Bay — four percent of total watershed load and seven percent of urban nonpoint sources. Runoff from industrial facilities is estimated to contribute five percent of the total watershed load of nickel, and minor amounts of other metals. If effective source control measures are feasible, and some sources can be greatly reduced or

eliminated, load reductions could be significant, even as measured against the total watershed load.

According to SWRCB data, electroplaters, metal finishers and semiconductor manufacturers contribute almost all (96 percent) of the copper loading from sites covered by the statewide storm water permit for industrial activities. Runoff from electroplating facilities, in particular, contains reported concentrations of copper 7-8 times that found in residential runoff. This suggests that it may be effective to focus control efforts on these facilities.

It seems possible that some industries — particular electroplating — are responsible for a disproportionate amount of copper and nickel loading to storm water. However, additional data are needed to confirm this possibility.

The Program will pursue the following actions.

- The Program, working with one co-permittee, will work with local industries, on a pilot program within one co-permittee's jurisdiction, to create systematic, well-documented sampling program, designed to verify (or disprove) apparent elevated copper and nickel concentrations in runoff from electroplating, metal finishing and semiconductor manufacturing facilities. Concentration data will be compared with that from other industrial and commercial sites (e.g. parking lots). The sampling program will include enough discrete samples from enough different facilities to demonstrate significant differences in average runoff concentrations, will these exist. Detection limits will be sufficiently low to avoid non-detect data. Analyses should be backed up by appropriate QA/QC documentation. The data will be analyzed to determine if specific industrial classifications do, indeed, have substantially higher average runoff concentrations.

  In particular, the Program and the co-permittee will work with industry to develop sampling and analysis protocols and will conduct independent sampling and analyses (spot-checking through duplicate or split samples) to verify data.

- If specific industries are "hot spots" for concentrations of copper and nickel in runoff, and there is no apparent link to housekeeping and materials storage and handling, the co-permittees will work with industry to investigate other potential pathways to urban runoff, such as aerial deposition of metals dust emanating from ventilation systems or from materials handling areas.

6.3.2 New Control Measures for Construction Site Erosion

The following two controls will be implemented to further enhance the Program's construction site erosion control activities.

EROSION-1	Implement Performance Standards for Construction Inspection.
EROSION-2	Participate in development of a region-wide training and certification program for construction site inspectors.

According to estimates in Section 5.0, construction site erosion contributes 1 percent of the total watershed load of copper, and 5 percent of nickel. In addition to nickel, significant amounts of lead, and some selenium and mercury are also associated with construction site erosion.

These estimates are uncertain. However, it is apparent that:

- The nickel load from construction site erosion is minor but effective controls could contribute to reductions in total loading.
- It is technically feasible to effectively control most erosion from construction sites, through a combination of project scheduling and planning, revegetation, and the seasonal use of proven temporary erosion control techniques.

Based on current understanding of sources and potential controllability, the Program and co-permittees should seek to minimize construction site erosion through consistent implementation of cost-effective, state-of-the-art methods. Specific methods are detailed in various references used in the Bay area. However, according to recent Regional Board staff reports, implementation in this Region is still uneven.

The rigorous application of proven, available, erosion control techniques can reduce potential sediment loads from a given site by orders of magnitude. The limiting factor appears to be how consistently techniques are applied (or enforced). Co-permittees may be able to increase the effectiveness of their erosion control programs by developing and implementing consistent administrative mechanisms for enforcing erosion control requirements.

6.4 PROGRAM PARTICIPATION IN COLLABORATIVE REGIONAL EFFORTS TO METALS CONTROL

The Program's metals control priorities and actions emphasize control of the sources of pollutants associated with the urban portions of the watershed and with activities that are clearly within the jurisdiction of the Program. Achieving control of regional sources that act on a watershed scale (e.g., vehicular related sources) will require that the Program to cooperate with the efforts of regulatory agencies, private businesses, and nonprofit organizations. In addition, the Program must integrate all of its efforts, including those which do not have significant metals control benefits, into a unified and comprehensive plan.

6.4.1 Coordinate with efforts to establish a Brake Pad Partnership to reduce Copper from brake pads

Based on the source evaluation in Section 5.0, brake pads are the major source of copper in urban runoff. The percent of copper in brake pads varies with brand from negligible to over 10 percent. Brake pads also contribute relatively minor amounts of lead to the environment. The percent of lead and zinc in brake pad friction materials varies from brand to brand —from undetectable levels to 1 percent lead and 19 percent zinc in a Volkswagen brake pad (Woodward-Clyde 1994).

The source could be reduced or eliminated by reformulating the content of brake pads. However, based on studies of the effectiveness of existing BMPs such as street sweeping and storm drain cleaning, and based on experience with the feasibility of treatment controls such as catch basin inserts, only a small portion of copper from brake pad dust can be controlled once the dust is released to the environment. Therefore, to control copper from automotive sources, source reduction, i.e., changing the metals content of brake pads appears to be the preferred long-term strategy.

Although it has been known since 1992 that brake pads are a major source of copper loading to San Francisco Bay (SCVNPSPCP 1992), efforts to control the source directly have been slow to develop. Primarily, this is because federal and state agencies, not local agencies, have regulatory authority over brake pads. Copper from brake pad dust affects water bodies throughout the state and the country, and the Program must defer to a nationally based effort to influence automobile parts manufacturers. EPA has authority to take action under the Toxic Substances Control Act, but even here, there is no clear regulatory mechanism (Engberg 1995). For these reasons, brake pad dust is not locally "controllable."

The City of Palo Alto initiated the effort to develop a national, voluntary program to reduce copper levels in brake pads. Common Ground for the Environment (a project of Stanford Law School and Sustainable Conservation) is conducting a process leading toward a Brake Pad Partnership. The process is supported by the San Francisco Estuary Project, various municipal storm water programs, USEPA, and private foundations and companies.

The process has already included a June 1996 National Stakeholder Forum. A work group was conveneed to explore technical issues and barriers to reducing copper levels in brake pads. A workplan for "developing a framework for a partnership agreement" for voluntary reductions on copper levels in brake pads has been prepared (Common Ground for the Environment 1996).

The City of Palo Alto has helped Common Ground secure project financing. About $190,000 has been raised for the project since late 1995; but funding is not guaranteed beyond mid-1997 (Moran 1997).

The Program believes that creation of a Brake Pad Partnership presents the best opportunity currently available to reduce the primary urban copper source load to San Francisco Bay, and commits to the following control measures to reduce copper from brake pads.

AUTO-1	Assist efforts to create a Brake Pad Partnership to promote reformulation of friction materials in brake pads.
AUTO-2	Participate in educating the storm water community (agency staff, regulatory staff, elected officials, consultants) about the significance of metals loading from brake pads.
AUTO-3	Participate in educating the public about the significance of metals loading from brake pads.
AUTO-4	Monitor, and respond to, research reports that could lead to an effective methodology for prioritizing cleaning of "hot spot" catch basins.

Under Control Measure AUTO-1, the Program will assist Common Ground for the Environment in its effort to create a Brake Pad Partnership. This will include providing a limited amount of funding, in addition to staff participation. The Program will continue to encourage efforts at a national level which will help encourage manufacturers to reformulate the friction materials in brake pads. In addition, the Program will encourage the Brake Pad Partnership to check the feasibility of incentives provided by local governments that could be included in a partnership agreement, such as public-agency fleet-purchasing preferences for copper-free brake pads.

The Program believes that the source identification work conducted as part of this study, along with the Program's previous analyses of metals loading, are essential to focussing the attention of regulators, environmentalists and others on the singular importance of brake pads to watershed loading of metals. The Program will continue to educate interested parties in the storm water community (AUTO-2) as well as the public (AUTO-3).

The current understanding of the fate and transport of copper originating in brake pad dust suggests that copper from this source is unlikely to be effectively trapped or concentrated in catch basins. However, it has been suggested that there may be some marginal benefit in more frequent cleaning of storm drain inlet "hot spots". The Program will continue to review research articles and reports, and will respond to any new information that would assist co-permittees to profile and identify locations that may be "hot spots" (AUTO-4).

6.4.2 Cooperate with the BAAQMD and Congestion Management Agency to Reduce Air Emissions of Metals

Tailpipe emissions of fine particulate dust are a documented human health hazard, but contribute less than 1 percent of the watershed total copper loading. Most of the metals loading is associated with diesel vehicles, particularly diesel-powered heavy trucks, which discharge a disproportionate amount of mercury relative to total vehicle miles travelled. Tailpipe emissions are associated with a substantial portion (14 percent) of total mercury loading to the Bay, as well as about 1 percent of total nickel loading. Significant amounts of lead, zinc and silver also come from this source.

The Program believes that this source is best controlled through action by the Bay Area Air Quality Management District (BAAQMD). In ongoing discussions, the Program will encourage BAAQMD to consider actions (e.g. requiring reformulation of fuels) that could reduce this source of mercury and nickel to urban runoff. Tailpipe emissions can also be reduced by minimizing the number of miles driven by vehicles in the Bay Area. This can be acheived by encouraging carpooling and providing alternative modes of transportation to the public. This particular function rests with the local transportation agency which is the congestion management agency (CMA) in Santa Clara County. The Program will partner with the CMA to control metals emissions through congestion management.

AIR -1	Partner with BAAQMD to reduce metals emissions from diesel-powered vehicles, and with the CMA to reduce, through congestion management, emissions from all vehicles

Industrial stack emissions contribute 3 percent of the total watershed load of nickel. As it is implemented, BAAQMD's Toxic Air Contaminant Reduction Plan will reduce metals from this source significantly.

AIR - 2	Support BAAQMD implementation of Toxic Air Contaminant Reduction Plan

6.4.3 Cooperate with Santa Clara Basin Watershed Management Initiative (WMI)

Most state water-quality programs have been focussed on controlling point-source discharges. Despite the success of the National Pollutant Discharge Elimination System permit program, many watershed problems are still unresolved. Throughout the nation, there is a growing consensus that many of these problems can best be addressed by a more integrated, basin-wide approach.

The watershed management approach expands the scope of water quality protection, and has four main features:

- targeting priority problems,
- stakeholder involvement,
- integrated solutions that make use of the expertise and authority of multiple agencies, and
- measuring success through strategic monitoring and data gathering.

The Regional Board's Watershed Management Initiative (WMI) targets the Santa Clara Basin for development of a pilot effort to develop a true watershed-based water quality and habitat-protection program in an urban watershed. The Program and co-permittees are contributing to this effort in many different ways, including participation in an ad-hoc "watershed core group" that meets each month. The group has drafted a mission statement and is developing plans for a more formal establishment of the planning structure, process, and timeline.

Representatives from the cities of Palo Alto, Sunnyvale, and San Jose participate in a Bay Monitoring and Modeling Subgroup. This subgroup is developing a workplan to address technical issues (including pollutant fate and transport), and regulatory issues, related to Bay water quality. A separate Watershed Monitoring Subgroup has also been established to address the freshwater areas of the Santa Clara Basin.

The Program believes that the WMI, together with the Regional Monitoring Program, presents the best opportunity to work toward investigating and controlling (if feasible and necessary) ~~nickel (estimated annual load of 9,916 from nonurban sources vs. 2,224 from urban nonpoint)~~. Similarly, this approach should be used to address the other three pollutant metals of concern (mercury, silver and selenium), which have predominantly non-urban sources within the watershed.

The WMI also allows consideration of pollutant metals in the context of defining, preserving and enhancing the beneficial uses of water bodies within the watershed. In particular, the ecological effects of pollutant metals can be considered in the context of other, non-chemical, impediments to the attainment of beneficial uses. Likewise pollutant reduction measures can be prioritized in the context of other measures which may be required to preserve and enhance beneficial uses.

6.5 INTEGRATION OF CONTROL MEASURES INTO THE REVISED 1997 URBAN RUNOFF MANAGEMENT PLAN

6.5.1 Annual Reporting

The Program's new metals control measures must be integrated with the co-permittees' other tasks and priorities. This integration can best be accomplished by incorporating metals control tasks into the Program's forthcoming Urban Runoff Management Plan (URMP) to be submitted to the Regional Board in September 1997. The URMP will specify how co-permittees will report their ongoing activities (such as street sweeping, storm drain maintenance, and industrial inspections) that help control metals.

One of the features of the URMP will be a comprehensive description of model Performance Standards covering most program activities, and where applicable, individual co-permittee Performance Standards that apply to specific municipalities.

The URMP will provide for reporting progress of ongoing activities as well as the new metals control measures specified above. The Program's annual reports will include documentation similar to that described in Table 6-6.

TABLE 6-6
DOCUMENTATION OF CONTROL MEASURES IN ANNUAL REPORTS

Activity	Documentation in Annual Reports
Ongoing Activities	
Public Agency Activities	Document and evaluate the activity, and discuss the potential metals control benefits achieved by co-permittees.
Public Information/ Participation	Document and evaluate the activity, and discuss the potential metals control benefits achieved by co-permittees.
Illicit Discharge Elimination	Document and evaluate the activity, and discuss the potential metals control benefits achieved by co-permittees.
Commercial/Industrial Inspections	Document and evaluate the activity, and discuss the potential metals control benefits achieved by co-permittees.
New Development and Construction	Document and evaluate the activity, and discuss the potential metals control benefits achieved by co-permittees.
New Metals Control Activities	
AUTO-1	Report on assistance to, and cooperation with, efforts to establish a Brake Pad Partnership
AUTO-2	Report on efforts to educate the storm water community about the significance of metals loading from brake pads.
AUTO-3	Report on efforts to educate the public about the significance of metals loading from brake pads.
AUTO-4	Update current state-of-the-art in reducing copper by selective catch-basin cleaning.
INDUSTRIAL-1	Describe progress by Program and industry (and co-permittees' contributions) toward improving sampling and analysis of runoff from selected industries.
INDUSTRIAL-2	Implementation depends on the results of INDUSTRIAL-1.
AIR-1	Report on discussions/participation with BAAQMD.
EROSION-1	Discuss potential metals control benefits achieved by co-permittees' implementation of performance standards.
EROSION-2	Discuss progress on region-wide training and certification program for construction inspectors.
AIR-2	Report on discussions/participation with BAAQMD.

6.5.2 Periodic Assessment and Continuous Improvement

The Program believes that the metals control measures identified herein are the most effective possible approach, available to the Program and co-permittees, for reducing the watershed loading of pollutant metals of concern (particularly copper). Despite uncertainties regarding the fate and transport of brake pad dust, it is clear that control of this source, through product reformulation, is the highest priority for reducing the effects of urban runoff pollutant metals on the beneficial uses of the South Bay.

Knowledge and perspectives on pollutant loading, fate and transport, and effects on beneficial uses are continually advancing. The Program is committed to a continual integration of new knowledge and perspectives as these become available. Program staff is well-situated to keep abreast of new knowledge and perspectives through participation in related programs, including the Brake Pad Partnership, BAAQMD, WMI, the Regional Monitoring Program, BASMAA, and others. Part of this effort will also focus on seeking opportunities to better understand and quantify sources and loading estimates identified in Section 5.11.

The Program will continually seek new opportunities to control pollutants from urban sources that enter storm water runoff. These opportunities may arise through participation in related programs, through the Program's own experience in implementing current controls, and through perusal of new data and scientific reports. The Program will document this process, identify new opportunities, and translate these opportunities into new tasks (or updates to existing tasks) in its annual work plans.

This process for continuous improvement is discussed and diagrammed in the Program's 1997 URMP.

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